INSTRUCTIONS

• Use black ink or black ball-point pen.
• 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

• There are 100 marks available on this paper.
• 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.

DO NOT TURN OVER UNTIL TOLD TO DO SO
This question is about copper sulfate.

Blue copper sulfate turns white when it is heated.

The word equation for the reaction is:

\[
\text{hydrated copper sulfate} \rightleftharpoons \text{anhydrous copper sulfate} + \text{water}
\]

blue \rightleftharpoons white

What name is given to hydrated copper sulfate in this reaction?

Tick ONE box. [1 mark]

- Catalyst
- Element
- Product
- Reactant
What does the symbol \( \rightleftharpoons \) mean?

Tick ONE box. [1 mark]

- [ ] Endothermic
- [ ] Exothermic
- [ ] Reversible
- [ ] Polymerisation

Complete the sentence. [1 mark]

The colour change when water is added to anhydrous copper sulfate is white to ____________________.

[Turn over]
A student heats 2.5 g of hydrated copper sulfate in a test tube.

0.9 g of water is given off.

The remaining solid is anhydrous copper sulfate.

01.4 Calculate the mass of anhydrous copper sulfate produced. [1 mark]

Mass of anhydrous copper sulfate =

_____________________________ g
Calculate the percentage of water contained in 2.5 g of hydrated copper sulfate. [2 marks]

Percentage of water = ________________ %
Draw ONE line from each compound to the formula for the compound. [2 marks]

<table>
<thead>
<tr>
<th>Compound</th>
<th>Formula for the compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper sulfate</td>
<td>CuO</td>
</tr>
<tr>
<td></td>
<td>CuS</td>
</tr>
<tr>
<td></td>
<td>CuSO₄</td>
</tr>
<tr>
<td>Water</td>
<td>H₂O</td>
</tr>
<tr>
<td></td>
<td>H₂SO₄</td>
</tr>
</tbody>
</table>
This question is about fuels.

Octane ($C_8H_{18}$) is a hydrocarbon in petrol.

Cracking breaks down large hydrocarbon molecules into smaller hydrocarbon molecules.

Which hydrocarbon molecule can be cracked to produce octane, $C_8H_{18}$?

Tick ONE box. [1 mark]

- $C_4H_8$
- $C_4H_{10}$
- $C_8H_{16}$
- $C_{12}H_{26}$

[Turn over]
What type of carbon compound is octane, $\text{C}_8\text{H}_{18}$?

Tick ONE box. [1 mark]

- Alcohol
- Alkane
- Carboxylic acid
- Ester

Oxygen is needed to burn fuels.

Name the source of the oxygen needed to burn fuels. [1 mark]
Particulates and sulfur dioxide are pollutants produced when some fuels burn.

Draw ONE line from each pollutant to the polluting effect. [2 marks]

<table>
<thead>
<tr>
<th>POLLUTANT</th>
<th>POLLUTING EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulates</td>
<td>Acid rain</td>
</tr>
<tr>
<td></td>
<td>Global dimming</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>Global warming</td>
</tr>
<tr>
<td></td>
<td>Landfill</td>
</tr>
<tr>
<td></td>
<td>Sewage sludge</td>
</tr>
</tbody>
</table>

[Turn over]
Which TWO gases are produced when fuels burn in car engines?

Tick TWO boxes. [2 marks]

- Ammonia
- Carbon dioxide
- Carbon monoxide
- Nitrogen
- Oxygen
Vehicles produce most of the atmospheric pollution in cities.

How could the atmospheric pollution in cities be reduced? [2 marks]

Tick TWO boxes.

- Build more roads in cities
- Build new car factories
- Develop fuel efficient engines
- Make car tax cheaper
- Use electric cars

[Turn over]
Polymers are used to make fabrics.

TABLE 1 shows some properties of two polymers.

**TABLE 1**

<table>
<thead>
<tr>
<th>Property</th>
<th>Polymer J</th>
<th>Polymer K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density in g/cm³</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Melting point in °C</td>
<td>165</td>
<td>260</td>
</tr>
<tr>
<td>Flame resistance</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Water absorption</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>
Polymer fabrics are used to make firefighter uniforms.

Complete TABLE 2 by deciding for each property whether polymer J or polymer K is BEST for firefighter uniforms.

Use TABLE 1, on page 14.

Density has been completed for you.

Tick THREE boxes. [2 marks]

**TABLE 2**

<table>
<thead>
<tr>
<th>Property</th>
<th>Polymer J</th>
<th>Polymer K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density in g/cm³</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Melting point in °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flame resistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water absorption</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Turn over]
Repeat of TABLE 1

<table>
<thead>
<tr>
<th>Property</th>
<th>Polymer J</th>
<th>Polymer K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density in g/cm³</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Melting point in °C</td>
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<td>260</td>
</tr>
<tr>
<td>Flame resistance</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Water absorption</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>
A firefighter uniform made from polymer J has a mass of 6.0 kg

Calculate the mass of a uniform of the same size made from polymer K.

Use TABLE 1, on page 16, and the equation:

mass of uniform made from polymer K = \frac{\text{density of polymer K}}{\text{density of polymer J}} \times 6.0

[2 marks]

Mass of uniform made from polymer K = 

__________________________________________ kg

[Turn over]
Polymers J and K are both thermosoftening polymers.

Polymer L is a thermosetting polymer.

Why would polymer L be better than polymers J and K for firefighter uniforms?

Tick ONE box. [1 mark]

- Polymer L burns easily
- Polymer L does not biodegrade
- Polymer L will not melt
Polymers J and K are made from crude oil.

In the past, firefighter uniforms were made from wool.

Wool is obtained from sheep.

Why are many fabrics made from polymers instead of wool?

Tick ONE box. [1 mark]

- Polymers are man-made
- Polymers are more hard-wearing
- Wool is more easily available
- Wool is more flame resistant

[Turn over]
Why is wool more sustainable than polymers J and K for making firefighter uniforms? [2 marks]

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

[Turn over]
A 9 carat gold ring is made from a mixture of metals.

TABLE 3 shows the mass of different metals in the ring.

The mass of the ring is 5.0 g

**TABLE 3**

<table>
<thead>
<tr>
<th>Metal</th>
<th>Mass of metal in g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>1.9</td>
</tr>
<tr>
<td>Silver</td>
<td>2.8</td>
</tr>
<tr>
<td>Copper</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Plot the data for copper from TABLE 3 on FIGURE 1. [2 marks]
Repeat of TABLE 3

<table>
<thead>
<tr>
<th>Metal</th>
<th>Mass of metal in g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>1.9</td>
</tr>
<tr>
<td>Silver</td>
<td>2.8</td>
</tr>
<tr>
<td>Copper</td>
<td>0.3</td>
</tr>
</tbody>
</table>
The cost of gold is £30 per gram.

Calculate the cost of the gold used in the 9 carat gold ring.

Use TABLE 3, on page 24. [1 mark]

Cost of gold = £

Rings can be made from 22 carat gold.

The ratio of the mass of gold in 22 carat gold compared to 9 carat gold is 22 : 9

Calculate the mass of gold in a 22 carat gold ring of mass 5.0 g

Use TABLE 3. [2 marks]

Mass of gold = g

[Turn over]
Pure gold is 24 carat.

Suggest TWO reasons why silver and copper are mixed with gold to make 9 carat gold rings. [2 marks]

1  

2  

Copper is obtained from copper ores or by recycling copper.

- Copper ores are non-renewable.
- Copper ores can be obtained by mining.
- Some scrap copper goes to landfill sites.

Give THREE reasons why we should use recycled copper instead of copper from copper ores. [3 marks]

1. 

2. 

3. 

[Turn over]
A student investigated the colours in three different flowers, A, B and C, using paper chromatography.

The colours are soluble in ethanol but are insoluble in water.

This is the method used.

1. Place ethanol in a beaker.

2. Add the flower.

3. Stir until the colours dissolve in the ethanol.

4. Filter the mixture.

5. Put spots of the coloured filtrate on the chromatography paper.
The filtrate was a very pale coloured solution.

How could the student obtain a darker coloured solution?

Tick TWO boxes. [2 marks]

- Crush the flower
- Filter the mixture three times
- Use a larger beaker
- Use more ethanol
- Use more flowers

[Turn over]
FIGURE 2 shows the apparatus used.

FIGURE 2

- Lid
- Beaker
- Chromatography paper
- Start line in ink
- Water

A B C
What TWO mistakes did the student make in setting up the apparatus?

Tick TWO boxes. [2 marks]

- [ ] The paper does not touch the beaker
- [ ] The start line is drawn in ink
- [ ] The water level is below the start line
- [ ] Uses a lid on the beaker
- [ ] Uses water as the solvent

[Turn over]
Another student sets up the apparatus correctly.

FIGURE 3 represents the student’s results.

FIGURE 3
What TWO conclusions can be made from FIGURE 3?

Tick TWO boxes. [2 marks]

- Flower A contains a single pure colour
- Flowers A and B contain the same colours
- The colour in flower C is a mixture
- The colour in flower B was the least soluble
- Two of the colours have the same $R_f$ value

[Turn over]
The student records some measurements.

The measurements are:
- the colour from flower B moves 7.2 cm
- the solvent moves 9.0 cm

Calculate the $R_f$ value for the colour from flower B.

Use the equation:

$$R_f = \frac{\text{distance moved by colour}}{\text{distance moved by solvent}}$$

[2 marks]

$$R_f = \frac{7.2}{9.0}$$

$$R_f = 0.8$$

$R_f$ value = 0.8
Disposable cups are made from coated paper or poly(styrene).

FIGURE 4 represents the structure of poly(styrene).

FIGURE 4

\[
\left( \begin{array}{c}
\text{C}_6\text{H}_5 \\
\text{H} \\
\text{C} \\
\text{C} \\
\text{H} \\
\text{H}
\end{array} \right)_{n}
\]
Which small molecule is used to produce poly(styrene)?

Tick ONE box. [1 mark]

- H \ H
  C═C
  \ H \ H

- C₆H₅H
  C═C
  \ H \ H

- CH₃ \ H
  C═C
  \ H \ H

- C₆H₅C₆H₅
  C═C
  \ H \ H

[Turn over]
Which process is used to make poly(styrene) from small molecules?

Tick ONE box. [1 mark]

- Cracking
- Distillation
- Fermentation
- Polymerisation
Complete the sentences.

Choose answers from the list below. [3 marks]

- ceramics
- composites
- four
- many
- monomers
- polymers
- two

Poly(styrene) is produced from small molecules called ________________.

When poly(styrene) is made, ________________ styrene molecules join to form large molecules.

These large molecules are called ________________.

[Turn over]
TABLE 4 gives some information about disposable cups.

TABLE 4

<table>
<thead>
<tr>
<th>Source of raw materials</th>
<th>Coated paper cups</th>
<th>Poly(styrene) cups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wood</td>
<td>Crude oil</td>
</tr>
<tr>
<td>Energy to make 1 cup in arbitrary units</td>
<td>550</td>
<td>200</td>
</tr>
<tr>
<td>Biodegradable</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Recyclable</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Compare the advantages and disadvantages of using coated paper and poly(styrene) to make disposable cups.

Use TABLE 4 and your knowledge and understanding of life cycle assessments (LCAs). [4 marks]
A student investigated how concentration affects the rate of reaction between magnesium and hydrochloric acid.

This is the method used.

1. Place hydrochloric acid in a conical flask.
2. Add magnesium powder.
3. Collect the gas produced in a gas syringe.
4. Measure the volume of gas every 40 seconds for 160 seconds.
5. Repeat steps 1–4 three more times.
6. Repeat steps 1–5 with hydrochloric acid of a higher concentration.
FIGURE 5 shows a gas syringe.

What is the volume of gas in the syringe? [1 mark]

Volume = cm³

[Turn over]
Which TWO variables should the student keep the same to make the investigation a fair test?

Tick TWO boxes. [2 marks]

- Concentration of hydrochloric acid
- Mass of magnesium powder
- Temperature of hydrochloric acid
- Time for reaction to end
- Volume of gas collected

[Turn over]
TABLE 5 shows the student’s results for the experiment with hydrochloric acid of a lower concentration.

TABLE 5

<table>
<thead>
<tr>
<th>Time in seconds</th>
<th>Volume of gas collected in cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test 1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>46</td>
</tr>
<tr>
<td>80</td>
<td>78</td>
</tr>
<tr>
<td>120</td>
<td>98</td>
</tr>
<tr>
<td>160</td>
<td>100</td>
</tr>
</tbody>
</table>
Calculate mean value X in TABLE 5, on page 46.

Do NOT include the anomalous result in your calculation.

Give your answer to 2 significant figures.

[2 marks]

X = ______________________ cm³
Repeat of TABLE 5

<table>
<thead>
<tr>
<th>Time in seconds</th>
<th>Volume of gas collected in cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test 1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>46</td>
</tr>
<tr>
<td>80</td>
<td>78</td>
</tr>
<tr>
<td>120</td>
<td>98</td>
</tr>
<tr>
<td>160</td>
<td>100</td>
</tr>
</tbody>
</table>

07.4 Plot the data from TABLE 5 on FIGURE 6, on page 49.

You should include your answer to Question 07.3.

You do NOT need to draw a line of best fit. [2 marks]
FIGURE 6

Mean volume of gas collected in cm$^3$

Time in seconds
FIGURE 7 shows results of the experiment with the hydrochloric acid of a higher concentration.

FIGURE 7

Mean volume of gas collected in cm$^3$
Calculate the mean rate of reaction between 0 and 50 seconds.

Use FIGURE 7 and the equation:

\[
\text{mean rate of reaction} = \frac{\text{mean volume of gas collected}}{\text{time taken}}
\]

[2 marks]

\[
\text{Mean rate of reaction} = \ \text{cm}^3/\text{s}
\]
Repeat of FIGURE 7

Mean volume of gas collected in cm$^3$

Time in seconds
Describe how the RATE OF REACTION changes between 0 and 160 seconds.

Use FIGURE 7, on page 52. [3 marks]
The student concludes that the rate of reaction is greater when the concentration of hydrochloric acid is higher.

Why is the rate of reaction greater when the concentration of hydrochloric acid is higher?

Tick TWO boxes. [2 marks]

- The particles are moving faster
- The particles have more energy
- The surface area of magnesium is smaller
- There are more particle collisions each second
- There are more particles in the same volume
The student tests the gas produced by bubbling it through limewater.

No change is seen in the limewater.

Give ONE conclusion the student can make about the gas. [1 mark]

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

The student tests the gas produced using a burning splint.

Name the gas the student is testing for.

Give the result of a positive test for this gas. [2 marks]

Name of gas ____________________________

_________________________________________________________________

Result ________________________________
This question is about chemicals in fireworks.

Coloured flames are produced because of the metal ions in the fireworks.

What colour flame would sodium ions produce? [1 mark]

Name a metal ion that would produce a green flame. [1 mark]
Some fireworks contain a mixture of metal ions.

Why is it difficult to identify the metal ions from the colour of the flame? [1 mark]
Flame emission spectroscopy is used to identify metal ions in a firework.

FIGURE 8 shows:
- the flame emission spectra of five individual metal ions
- a flame emission spectrum for a mixture of two metal ions.

FIGURE 8
Which TWO metal ions are in the mixture?

Tick TWO boxes. [2 marks]

☐ Ca$^{2+}$

☐ Cu$^{2+}$

☐ K$^+$

☐ Li$^+$

☐ Na$^+$

[Turn over]
The compounds in fireworks also contain non-metal ions.

A scientist tests a solution of the chemicals used in a firework.

\[ \text{Silver nitrate solution and dilute nitric acid are added to the solution.} \]

A cream precipitate forms.

Which ion is shown to be present by the cream precipitate? [1 mark]
Describe a test to show the presence of sulfate ions in the solution.

Give the result of the test if there are sulfate ions in the solution. [3 marks]

Test

Result

[Turn over]
Methylated spirit is a useful product made from a mixture of substances.

TABLE 6 shows the mass of the substances in a sample of methylated spirit.

TABLE 6

<table>
<thead>
<tr>
<th>Substance</th>
<th>Mass in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>265.5</td>
</tr>
<tr>
<td>Methanol</td>
<td>23.3</td>
</tr>
<tr>
<td>Pyridine</td>
<td>3.0</td>
</tr>
<tr>
<td>Methyl violet</td>
<td>1.5</td>
</tr>
</tbody>
</table>

What name is given to a useful product such as methylated spirit? [1 mark]
Calculate the percentage by mass of methanol in methylated spirit.

Use TABLE 6, on page 62. [2 marks]

Percentage = ______________________ %

[Turn over]
Methylated spirit contains ethanol and is available cheaply.

Methylated spirit also contains:
- pyridine which has a very unpleasant smell
- methyl violet which makes the mixture purple.

09.3 Suggest why pyridine and methyl violet are added to ethanol to make methylated spirit. [1 mark]

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

09.4 Suggest ONE use of methylated spirit. [1 mark]

__________________________________________________________________________

__________________________________________________________________________
09.5 Describe how ethanol is produced from sugar solution.

Give the name of this process. [3 marks]

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

[Turn over]
09.6 FIGURE 9 shows part of the displayed formula for ethanol.

Complete FIGURE 9. [1 mark]

FIGURE 9

H

H—C—C

H

09.7 Name the gas produced when sodium is added to ethanol. [1 mark]
Methanol is used to produce methanoic acid.

What type of substance reacts with methanol to produce methanoic acid? [1 mark]
This question is about gases.

FIGURE 10 shows how nitrogen is used in the Haber Process to produce ammonia.

FIGURE 10

Nitrogen  Gas X
\[ \rightarrow \]
React \[ \rightarrow \] Reactor
\[ \rightarrow \] Condenser
\[ \downarrow \]
Unreacted gases
\[ \downarrow \] Ammonia
10.1 Gas X in FIGURE 10 is obtained from methane.

Name gas X. [1 mark]

10.2 Give the approximate temperature and pressure used in the reactor. [2 marks]

Temperature

Pressure

10.3 The mixture of gases from the reactor cools in the condenser.

Suggest why ammonia condenses but the other gases do not. [1 mark]

[Turn over]
The Earth’s early atmosphere was different to Earth’s atmosphere today.

Scientists think that the Earth’s early atmosphere was like the atmosphere found on Venus today.

TABLE 7 shows the amounts of carbon dioxide and oxygen in the atmospheres of Venus and Earth today.

TABLE 7

<table>
<thead>
<tr>
<th>Gas</th>
<th>Percentage (%) in Venus’ atmosphere today</th>
<th>Percentage (%) in Earth’s atmosphere today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>96.50</td>
<td>0.04</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.00</td>
<td>20.95</td>
</tr>
</tbody>
</table>

The percentages of carbon dioxide and oxygen have changed from Earth’s early atmosphere to Earth’s atmosphere today.

Explain the processes that led to these changes. [6 marks]

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________
Why are scientists NOT certain about the percentage of each gas in the Earth’s early atmosphere? [1 mark]
There are no questions printed on this page
There are no questions printed on this page

<table>
<thead>
<tr>
<th>Question</th>
<th>Mark</th>
</tr>
</thead>
</table>

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