For this paper you must have:
- a ruler
- the Data Sheet (as an insert).
You may use a calculator.

Time allowed
- 60 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer all questions.
- You must answer the questions in the space provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- Question 8 should be answered in continuous prose. In this question you will be marked on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.

Advice
- In all calculations, show clearly how you work out your answer.
1 This picture shows a sword. The sword is about 3400 years old. It is made of an alloy called bronze.

Bronze is made from copper and tin.

Bronze made better swords than pure copper. This is because bronze is harder than pure copper.

1 (a) Draw a ring around the correct answer to complete the sentence.

An alloy is a mixture of

metals.  molecules.  non-metals.  

(1 mark)

1 (b) Pure copper can be quite easily bent out of shape.

Which two statements in the table explain why copper can be bent?

Tick (✓) two boxes.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Tick (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper atoms are arranged in layers.</td>
<td></td>
</tr>
<tr>
<td>Copper atoms are joined by strong covalent bonds.</td>
<td></td>
</tr>
<tr>
<td>Copper atoms can slide over each other.</td>
<td></td>
</tr>
<tr>
<td>Copper is made of small molecules.</td>
<td></td>
</tr>
</tbody>
</table>

(2 marks)
1 (c) Which one statement in the table explains why bronze is harder than pure copper?

Tick (√) one box.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Tick (√)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The copper and tin atoms are the same size.</td>
<td></td>
</tr>
<tr>
<td>The layers of atoms are distorted in bronze.</td>
<td></td>
</tr>
<tr>
<td>The copper and tin atoms are joined by strong covalent bonds in bronze.</td>
<td></td>
</tr>
</tbody>
</table>

(1 mark)
2 The diagram shows how the atoms are joined in part of a diamond.

2 (a) Draw a ring around the correct answer to complete each sentence.

2 (a) (i) Diamond has a high melting point because [ ] of the atoms are joined by strong bonds.

   some
   a few
   all

   (1 mark)

2 (a) (ii) Each atom is joined to [ ] other atoms.

   one
   two
   four

   (1 mark)

2 (a) (iii) The bonds are [ ]

   covalent.
   ionic.
   metallic.

   (1 mark)

2 (a) (iv) Diamond is used in cutting tools because it is [ ]

   hard.
   soft.
   shiny.

   (1 mark)
2 (b) Diamond is made of carbon.

Name a gas produced when carbon reacts with oxygen.

..............................................................................................................................................

(1 mark)
3 (a) Ammonia has the formula NH₃. It is made from nitrogen and hydrogen.

How many atoms are in an ammonia molecule? ..................................................

(1 mark)

3 (b) The diagrams show the electron arrangement in nitrogen and hydrogen.

Which diagram below, A, B, C or D, represents an ammonia molecule?

Write your answer in the box.  Diagram

(1 mark)

3 (c) Ammonia dissolves in water to form a solution with a pH of 10.

What does this pH value tell you about ammonia solution?

........................................................................................................................................

(1 mark)
3 (d) In industry a large amount of ammonia is neutralised by an acid to make ammonium nitrate.

3 (d) (i) What type of substance is ammonium nitrate?

Tick (√) one box.

- acid
- alkali
- base
- salt

(1 mark)

3 (d) (ii) Which acid is added to ammonia to make ammonium nitrate?

Tick (√) one box.

- hydrochloric
- citric
- nitric
- sulfuric

(1 mark)

3 (d) (iii) Draw a ring around the main use of ammonium nitrate.

fertiliser lubricating oil medicine plastic

(1 mark)

Question 3 continues on the next page
3 (e) Instant cold packs are used to treat sports injuries.

One type of cold pack has a plastic bag containing water. Inside the bag is a smaller bag containing ammonium nitrate.

The outer bag is squeezed so that the inner bag bursts. The ammonium nitrate dissolves in the water. This process is endothermic.

Explain why the bag becomes cold.

............................................................................................................................................
............................................................................................................................................
............................................................................................................................................
............................................................................................................................................

(2 marks)
4 Read the information in the box and then answer the questions.

### Sun Creams

Sun creams contain titanium oxide. This compound absorbs harmful radiation.

Traditional sun creams contain normal-sized particles of titanium oxide. Normal-sized particles of titanium oxide are known to be safe to put on the skin.

Many new sun creams contain nano-sized particles of titanium oxide.

Experiments suggest that nano-sized particles might pass through the pores of the skin more easily than normal-sized particles.

4 (a) Explain why nano-sized particles might pass more easily through the pores of the skin than normal sized particles.

.....................................................................................................................................................
.....................................................................................................................................................
.....................................................................................................................................................

(1 mark)

4 (b) Using these sun creams is beneficial because they absorb harmful radiation.

Suggest one possible risk of using these sun creams.

.....................................................................................................................................................
.....................................................................................................................................................
.....................................................................................................................................................

(1 mark)
5 The picture shows sodium reacting with chlorine. The reaction forms sodium chloride.

5 (a) Use words from the box to answer the questions.

| compound | element | hydrocarbon | mixture |

Which word best describes:

5 (a) (i) sodium ................................................................. (1 mark)

5 (a) (ii) sodium chloride? .................................................. (1 mark)

5 (b) When sodium reacts with chlorine the sodium atoms change into sodium ions.

The diagrams below represent a sodium atom and a sodium ion.

Sodium atom (Na)  Sodium ion (Na⁺)
Use the diagrams to help you explain how a sodium atom turns into a sodium ion.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

(2 marks)

5 (c) (i) The diagram below represents a chlorine atom.

![Diagram of chlorine atom]

When chlorine reacts with sodium the chlorine forms negative chloride ions.

Complete the diagram below to show the outer electrons in a chloride ion (Cl\(^{-}\)).

![Diagram of chloride ion]

(1 mark)

5 (c) (ii) Chloride ions are strongly attracted to sodium ions in sodium chloride.

Explain why.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

(1 mark)
Waste water from some industrial processes contains metal ions, such as chromium ions. These ions must be removed from the water before the water is returned to a river.

The equation shows a method of removing chromium ions from water.

\[
\text{CrCl}_3(\text{aq}) + 3\text{NaOH}(\text{aq}) \rightarrow \text{Cr(OH)}_3(\text{s}) + 3\text{NaCl}(\text{aq})
\]

6 (a) This type of reaction is called a precipitation reaction.

Describe what happens in a precipitation reaction

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
(1 mark)

6 (b) Complete the name of the substance with the formula NaOH.

Sodium .................................................................

(1 mark)

6 (c) Draw a ring around the method that could be used to separate the Cr(OH)$_3$(s) from the water.

electrolysis filtration neutralisation oxidation

(1 mark)

6 (d) It is important to remove chromium ions from water before it is returned to a river.

Suggest why.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
(1 mark)
7 (a) An atom of aluminium can be represented as shown below.

\[
\begin{array}{c}
\text{Mass number} \\
27 \\
\text{Al} \\
\text{Atomic number} \\
13
\end{array}
\]

In this atom of aluminium the number of protons is ......................... and the number of neutrons is .............................. .

(2 marks)

7 (b) Which statement in the table below describes the mass of an electron?

Tick (✓) one box.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Tick (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrons have a very small mass compared to protons.</td>
<td></td>
</tr>
<tr>
<td>Electrons have about the same mass as protons.</td>
<td></td>
</tr>
<tr>
<td>Electrons are much heavier than protons.</td>
<td></td>
</tr>
<tr>
<td>Electrons have about the same mass as neutrons.</td>
<td></td>
</tr>
</tbody>
</table>

(1 mark)

7 (c) Which method is used to extract aluminium from aluminium oxide?

Tick (✓) one box.

<table>
<thead>
<tr>
<th>Method</th>
<th>Tick (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating aluminium oxide.</td>
<td></td>
</tr>
<tr>
<td>Heating aluminium oxide with carbon.</td>
<td></td>
</tr>
<tr>
<td>Electrolysis of molten aluminium oxide.</td>
<td></td>
</tr>
<tr>
<td>Heating aluminium oxide with copper.</td>
<td></td>
</tr>
</tbody>
</table>

(1 mark)
Describe a method to make copper sulfate crystals from copper oxide and dilute sulfuric acid.

For the method you should include:

- the names of the pieces of apparatus used
- a risk assessment.
A student investigated the rate of reaction between marble and hydrochloric acid.

The student used an excess of marble.

The reaction can be represented by this equation:

$$\text{CaCO}_3(s) + 2\text{HCl}(aq) \rightarrow \text{CaCl}_2(aq) + \text{H}_2\text{O}(l) + \text{CO}_2(g)$$

The student used the apparatus shown in the diagram.

The student measured the mass of the flask and contents for ten minutes.

The results are shown on the graph. Use the graph to answer the questions.
9 (a) (i) Complete the graph by drawing a line of best fit.  

(1 mark)

9 (a) (ii) Use the graph to find the mass of the flask and contents after 1.8 minutes.

......................................... grams  

(1 mark)

9 (a) (iii) The rate of reaction can be measured by the steepness of the graph line.

Describe, as fully as you can, how the rate of reaction changes with time in this experiment.

.......................................................................................................................... ..................
.......................................................................................................................... ..................
.......................................................................................................................... ..................
.......................................................................................................................... ..................

(2 marks)

9 (b) The mass of the flask and contents decreased during the experiment.

Use the equation for this reaction to help you explain why.

.......................................................................................................................... ..................
.......................................................................................................................... ..................
.......................................................................................................................... ..................
.......................................................................................................................... ..................

(2 marks)

Question 9 continues on the next page
9 (c) A balance is used to measure the mass of the apparatus.

9 (c) (i) Which balance, A, B, or C, has the highest resolution?

![Balances A, B, C]

The balance with the highest resolution is balance .

(1 mark)

9 (c) (ii) The balance used for this experiment should have a high resolution.

Explain why.

.......................................................................................................................... ..................
.......................................................................................................................... ..................
.......................................................................................................................... ..................
.......................................................................................................................... ..................

(2 marks)

9 (d) The student repeated the experiment using powdered marble instead of marble chips.

The rate of reaction between the marble and hydrochloric acid particles was much faster with the powder.

Explain why.

.......................................................................................................................... ..................
.......................................................................................................................... ..................
.......................................................................................................................... ..................
.......................................................................................................................... ..................

(2 marks)
10 The diagram shows the main parts of an instrumental method called gas chromatography linked to mass spectroscopy (GC-MS).

This method separates a mixture of compounds and then helps to identify each of the compounds in the mixture.

10 (a) In which part of the apparatus:

10 (a) (i) is the mixture separated? .................................................................

(1 mark)

10 (a) (ii) is the relative molecular mass of each of the compounds in the mixture measured?

.................................................................

(1 mark)

Question 10 continues on the next page
10 (b) (i) Athletes sometimes take drugs because the drugs improve their performance. One of these drugs is ephedrine.

Ephedrine has the formula:

\[ \text{C}_{10}\text{H}_{15}\text{NO} \]

What relative molecular mass \((M_r)\) would be recorded by GC-MS if ephedrine was present in a blood sample taken from an athlete?

Show clearly how you work out your answer.

Relative atomic masses: H = 1; C = 12; N = 14; O = 16.

\[ \text{Relative molecular mass} = \text{..........................} \]

(2 marks)

10 (b) (ii) Another drug is amphetamine which has the formula:

\[ \text{C}_{9}\text{H}_{13}\text{N} \]

The relative molecular mass \((M_r)\) of amphetamine is 135.

Calculate the percentage by mass of nitrogen in amphetamine.

Relative atomic mass: N = 14

\[ \text{Percentage of nitrogen} = \text{..........................}\% \]

(2 marks)
10 (c) Athletes are regularly tested for drugs at international athletics events.
An instrumental method such as GC-MS is better than methods such as titration.
Suggest **two** reasons why.
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
(2 marks)

10 (d) When a blood sample is taken from an athlete the sample is often split into two portions.
Each portion is tested at a different laboratory.
Suggest why.
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
(2 marks)

END OF QUESTIONS