4. The diagrams below show stages in making the compound copper sulphate by reacting copper carbonate with dilute sulphuric acid.

**Stage 1**

![Image of Stage 1 with excess copper carbonate]

**Stage 2**

![Image of Stage 2 with unreacted copper carbonate and blue solution]

**Stage 3**

![Image of Stage 3 with blue solution]

*Excess* copper carbonate is added to dilute sulphuric acid and the mixture is continuously stirred.

Unreacted copper carbonate is removed.

The blue solution is left in an evaporating basin at room temperature to obtain blue crystals of copper sulphate.

(i) Explain why copper carbonate is added in *excess*. [1]

(ii) Choose, from the box above, the name for the process occurring in

I. Stage 2 .......................................................... [1]

II. Stage 3 .......................................................... [1]

(iii) Using the substances in the box above, write a word equation which represents the reaction described in stage 1. [2]

*carbon dioxide  copper carbonate  copper sulphate  sulphuric acid  water*

(iv) If sodium carbonate were used instead of copper carbonate, give the chemical name of the crystals formed in the evaporating basin in stage 3. [1]
9. The diagram below shows some reactions of dilute hydrochloric acid.

![Diagram showing the reactions]

Give the name for

(i) colourless solution \(A\) ........................................... [1]
(ii) gas \(B\) ......................................................... [1]
(iii) alkali \(C\) ....................................................... [1]
(iv) green powder \(D\) .................................................. [1]
2. The diagrams below show stages in making the compound copper sulphate by reacting copper oxide with dilute sulphuric acid.

Stage 1

Copper oxide is added to warm dilute sulphuric acid until all the acid is used up. The mixture is continuously stirred.

(i) Describe what you would expect to see when all the acid has been used up. [1]

(ii) Choose terms from the box below to answer parts I-III.

<table>
<thead>
<tr>
<th>boiling</th>
<th>copper oxide</th>
<th>copper sulphate</th>
<th>dissolving</th>
<th>evaporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>insoluble</td>
<td>soluble</td>
<td>sulphuric acid</td>
<td>water</td>
<td></td>
</tr>
</tbody>
</table>

Each term may be used once, more than once or not at all.

I. Give the property of copper oxide that allows it to be removed by filtering in Stage 2. [1]

II. Name the substance being removed during Stage 3. [1]

III. Write a word equation which represents the reaction in Stage 1. [2]
6. The diagram below shows the stages in making some **dry crystals** of copper sulphate by reacting copper carbonate with dilute sulphuric acid.

\[
\text{copper carbonate} + \text{sulphuric acid} \rightarrow \text{copper sulphate} + \text{water} + \text{carbon dioxide}
\]

Write a method describing how this experiment could be carried out.  

[4]
10. The diagram below shows some reactions of a common acid.

Give the name of

(a) acid A, ................................................................. [1]
(b) gas B, ................................................................. [1]
(c) gas C, ................................................................. [1]
(d) colourless solution D, ........................................... [1]
(e) black solid E, ....................................................... [1]
(f) blue solution F. .................................................... [1]
9. The diagram below shows some reactions of dilute sulphuric acid.

![Diagram](image_url)

Give the name for

(i) metal A, .......................................................... [1]
(ii) gas B, .......................................................... [1]
(iii) the colourless solution C, .................................. [1]
(iv) the blue solution D, ........................................... [1]
(v) black oxide E. .................................................. [1]
Rebecca was asked to investigate how the pH changed during the reaction between hydrochloric acid and potassium hydroxide. She slowly added potassium hydroxide solution to 25 cm$^3$ of dilute hydrochloric acid and recorded the pH using a pH sensor. The results are shown in the graph below.

![Graph showing pH change](image)

8. (a) (i) Use the graph to give

I. the pH of the hydrochloric acid before adding potassium hydroxide. [1]

II. the volume of potassium hydroxide required to neutralise the acid. [1]

(ii) Rebecca could also have investigated the pH change using universal indicator solution.

I. State the colour of universal indicator when the solution is neutral. [1]

II. Give one advantage of using a pH sensor to investigate changes in pH. [1]

(b) Acids also react with bases such as copper oxide.

Describe how a pure sample of copper sulfate crystals can be prepared from copper oxide. [3]
2. \((a)\) Sulfuric acid is a \textbf{strong} acid.

Place a tick (✓) in the box with the pH value of sulfuric acid.  

\begin{center}
\begin{tabular}{l|c|c|c|c|c}

pH value & 1 & 5 & 7 & 9 & 14 \\
\hline
\end{tabular}
\end{center}

\[(b)\] Give the chemical name of an acid other than sulfuric acid.  

\begin{center}
\hline
\end{center}

\[(c)\] Name the gas given off when dilute sulfuric acid reacts with sodium carbonate.  

\begin{center}
\hline
\end{center}
Copper sulfate crystals can be prepared by reacting copper carbonate with dilute sulfuric acid.

The unlabelled diagrams below show two of the three stages involved.

Describe the preparation of copper sulfate crystals by this method. Include in your answer what you would expect to see at each stage.
One of the major consequences of sulfur dioxide emission is the formation of acid rain. Acid rain causes the pH in lakes and reservoirs to decrease.

The graph below shows the change in the pH of a reservoir between 1982 and 2005.

(i) Describe how the pH and the acidity changes between 1982 and 2005. [2]

Acidity

(ii) The reservoir is in a remote part of the country and difficult to reach. pH readings were taken daily and used to produce the graph above.

Give the letter of the equipment above that you would choose to record and store the pH of the reservoir several times a day. Give a reason for your choice. [2]

Letter

Reason
8. The diagram below shows some reactions of dilute hydrochloric acid.

(a) Name the following substances.

- blue solution A .................................................................
- colourless gas B .................................................................
- alkali C ................................................................. [3]

(b) Balance the symbol equation for the reaction between zinc and dilute hydrochloric acid. [1]

\[ \text{Zn} + \square \text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2 \]
4. The following table shows the pH of some common substances.

<table>
<thead>
<tr>
<th>Substance</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>limewater</td>
<td>10.5</td>
</tr>
<tr>
<td>saliva</td>
<td>6.4</td>
</tr>
<tr>
<td>lemon juice</td>
<td>2.2</td>
</tr>
<tr>
<td>orange juice</td>
<td>2.6</td>
</tr>
<tr>
<td>milk of magnesia</td>
<td>10.0</td>
</tr>
</tbody>
</table>

(a) Use only information from the table to answer parts (i) and (ii).

(i) Name the strongest acid. [1]

(ii) Name the substance closest to being neutral. [1]

(b) Milk of magnesia is used to treat indigestion. It contains magnesium hydroxide which reacts with excess hydrochloric acid in the stomach.

(i) Complete the following word equation to show the products formed. [2]

magnesium hydroxide + hydrochloric acid → ........................................... + ...........................................

(ii) Another indigestion remedy contains calcium carbonate. Name the gas produced when calcium carbonate reacts with hydrochloric acid and state how this gas can be identified. [2]

Gas produced .................................................................

How this gas can be identified ..................................................

...........................................................................
4. A class of students was asked to carry out a neutralisation reaction as part of an experiment to prepare crystals of a salt. They carried out the first stage of the experiment using the apparatus shown below.

This stage of the experiment was carried out three times by five different groups. Their results are shown below.

<table>
<thead>
<tr>
<th>Group</th>
<th>Volume of sodium hydroxide needed to neutralise the hydrochloric acid (cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24.2 24.8 24.7</td>
</tr>
<tr>
<td>2</td>
<td>24.6 24.8 24.7</td>
</tr>
<tr>
<td>3</td>
<td>25.1 25.3 25.8</td>
</tr>
<tr>
<td>4</td>
<td>24.5 24.5 24.5</td>
</tr>
<tr>
<td>5</td>
<td>24.9 25.0 25.1</td>
</tr>
</tbody>
</table>

(a) Two of the results in the table should not be used when calculating a mean value for each group. Circle these results.
(b) Universal indicator is used to identify when neutralisation has occurred.

State how the pH will change as the reaction takes place and give the colour of the solution when neutral. [2]

(c) In the final stage of the experiment, the students used the following apparatus to crystallise their salt from a solution without universal indicator.

(i) Name the colourless liquid removed during evaporation. .......................................................... [1]

(ii) Give the chemical name for the salt formed. ................................................................................... [1]

(d) The experiment was repeated using sulfuric acid. Complete the word equation for the reaction. [1]

\[
\text{sodium hydroxide} + \text{sulfuric acid} \rightarrow \text{ } +
\]
4. (a) A pupil was asked to make a sample of zinc sulfate crystals from zinc carbonate.

He added *excess* zinc carbonate to dilute sulfuric acid, stirring continuously, until no more reacted.

(i) Describe the next two steps the pupil should carry out to obtain a sample of zinc sulfate crystals. [2]

(ii) The gas produced when zinc carbonate and dilute sulfuric acid react is carbon dioxide. Describe the test the pupil would carry out to show that the gas is carbon dioxide. Include the observation he would make. [1]

(iii) If zinc carbonate had not been available, give the name of another *compound* which the pupil could have reacted with dilute sulfuric acid to make zinc sulfate. [1]
6. (a) A group of pupils were investigating the effects of acid rain. They decided to look at the effect of dilute sulfuric acid on metals used in the building industry.

The metal samples were cleaned to give a shiny surface. The pupils tested the metals by adding dilute acid to each of the cleaned metal samples. The test tubes below show the observations the pupils made during the investigation.

○ = bubble of a colourless gas which 'pops' when tested with a lighted splint

aluminium  copper  iron  zinc

(i) Use the observations made during the reactions to list the metals in order of their reactivity and give the reason for your choice. [2]

Most reactive


Least reactive

Reason ____________________________

(ii) Complete the word equation below:

iron + sulfuric acid → ____________________________ + ____________________________ [1]

(iii) Suggest why sulfuric acid was used in this investigation and not other acids. [1]
8. The following diagram shows the pH scale and the pH values of some common substances.

(a) From the substances above, name

(i) the strongest acid, ............................................................ [1]
(ii) the weakest alkali, ............................................................ [1]
(iii) a neutral substance. .......................................................... [1]

(b) John was studying the reactions of acids with three different substances, A, B and C. He recorded his observations and temperature changes in the table shown below.

<table>
<thead>
<tr>
<th>Substance added to acid</th>
<th>Observations</th>
<th>Temperature change (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>bubbles of gas produced, gas collected turns limewater milky, substance reacts to produce blue solution</td>
<td>+4</td>
</tr>
<tr>
<td>B</td>
<td>no gas produced, substance reacts to produce a blue solution</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>no visible change</td>
<td>+8</td>
</tr>
</tbody>
</table>

Identify A, B and C from the substances in the box below. [3]

<table>
<thead>
<tr>
<th>copper carbonate</th>
<th>copper oxide</th>
<th>magnesium</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium chloride</td>
<td>sodium hydroxide</td>
<td></td>
</tr>
</tbody>
</table>
1. One method of preparing a salt is by reacting a base with a dilute acid. The information below shows the stages a pupil follows to make a salt.

Add copper(II) oxide to warm dilute sulfuric acid until all the acid has been used up, stirring continuously.

**Stage 1**

**Stage 2**

**Stage 3**

Leave the blue solution at room temperature for a few days.

---

**Use the information in the diagrams to answer the following questions.**

(a) State what the pupil can see when all the acid has been used up.  

(b) (i) Name the process used in stage 2.

(b) (ii) Name the substance removed during stage 3.

(c) (i) Give the name of the base used in this experiment.

(c) (ii) Give the name of the salt formed in this experiment.
4. Magnesium sulfate can be made by adding **excess** magnesium oxide to sulfuric acid. Magnesium oxide is insoluble in water.

(a) State why **excess** magnesium oxide is added.  

(b) The following apparatus could be used to remove the excess magnesium oxide from the solution. Complete the labelling of the diagram.  

(c) State how you can obtain crystals from the solution.  

(d) Complete the word equation for the reaction.  

\[ \text{magnesium oxide} + \text{sulfuric acid} \rightarrow \text{____________________} + \text{____________________} \]

(e) If the reaction was carried out with hydrochloric acid, instead of sulfuric acid, magnesium chloride would be formed. Write the chemical formula for magnesium chloride.  

\[ \text{____________________} \]
6. (a) Grapes contain tartaric acid. Place a tick (✓) in the box with the expected value for the pH of tartaric acid and explain your choice. 

<table>
<thead>
<tr>
<th>pH value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

Explanation ..................................................................................................................................
(b) Tim was asked to carry out an experiment to investigate the effect of food on the pH of saliva.

At the start of the experiment the pH of saliva in Tim's mouth was 6.9. He ate an apple and the pH of his saliva was measured every 5 minutes for 45 minutes.

The results of the experiment are shown in the table below.

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.9</td>
<td>5.7</td>
<td>5.0</td>
<td>4.5</td>
<td>4.5</td>
<td>5.0</td>
<td>5.7</td>
<td>6.1</td>
<td>6.4</td>
<td>6.6</td>
</tr>
</tbody>
</table>

(i) Five points have already been plotted. Complete the graph. [3]

(ii) Use the graph to give the minimum pH value obtained during the experiment. [1]

(iii) Use the graph to predict when the pH of Tim's saliva will return to its original value. [1]

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

minutes
1. Look at the chemicals and apparatus below. They are needed to prepare crystals of copper(II) sulfate.
There are three stages to the preparation of copper(II) sulfate crystals.

(a) Use the chemicals and apparatus shown on the opposite page. Draw diagrams to show how each stage would be carried out.

Stage 1
Reacting copper(II) carbonate with dilute sulfuric acid until no more dissolves

Stage 2
Removing unreacted copper(II) carbonate

Stage 3
Obtaining crystals of copper(II) sulfate
(b) Name the process described in Stage 2.

(c) Complete the word equation for the reaction taking place. Choose substances from the box below.

<table>
<thead>
<tr>
<th>carbon dioxide</th>
<th>hydrogen</th>
<th>copper(II) sulfate</th>
</tr>
</thead>
<tbody>
<tr>
<td>water</td>
<td>copper(II) chloride</td>
<td></td>
</tr>
</tbody>
</table>

copper(II) carbonate + sulfuric acid → __________________ + __________________ + __________________
6. The graph below shows the temperature recorded when 50 cm³ of dilute sulphuric acid solution was added, 1 cm³ at a time, to 20 cm³ of sodium carbonate solution.

![Graph showing temperature vs. volume of sulphuric acid.]

(a) Use the graph to give the

(i) temperature of the sodium carbonate solution before any sulphuric acid was added, \[\ldots\] °C [1]

(ii) maximum temperature reached during the reaction, \[\ldots\] °C [1]

(iii) volume of sulphuric acid needed to use up all the sodium carbonate, \[\ldots\] cm³ [1]

(b) (i) Insert the names of three products to complete the word equation for the reaction between sulphuric acid and sodium carbonate. [2]

\[
\text{sulphuric acid} + \text{sodium carbonate} \rightarrow \ldots + \ldots + \ldots
\]

(ii) Give the chemical formula of the salt formed during the reaction. [1]
7. The following table shows the colours of universal indicator at different pH values.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Red</th>
<th>Orange</th>
<th>Yellow</th>
<th>Green</th>
<th>Blue</th>
<th>Navy Blue</th>
<th>Purple</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>0 - 2</td>
<td>3 - 4</td>
<td>5 - 6</td>
<td>7</td>
<td>8 - 9</td>
<td>10 - 12</td>
<td>13 - 14</td>
</tr>
</tbody>
</table>

(i) A solution turns universal indicator purple.

I. Give the pH range of this solution. [1]

II. State what the pH range tells us about this solution. [1]

(ii) Limewater is a solution of calcium hydroxide.
A student noticed that on adding some hydrochloric acid to limewater, a chemical reaction took place, with the temperature increasing by 3°C.

I. State the word used to describe the type of reaction that takes place between hydrochloric acid and limewater. [1]

II. State and explain what happened to the pH value of 11 for limewater when excess hydrochloric acid was added. [2]
Sulphuric acid and ethanoic acid are two common acids. They both have a pH below 7 and turn litmus red. Both react with alkalis to produce a salt and water. This type of reaction is known as neutralisation.

An example of neutralisation is the reaction between sulphuric acid and sodium hydroxide to produce sodium sulphate and water.

Acids also react with metals. Sulphuric acid reacts with magnesium to produce magnesium sulphate and hydrogen. The reaction is fast and produces a lot of bubbles. It produces heat and is therefore an exothermic reaction. Ethanoic acid reacts more slowly with magnesium and the reaction produces less heat.

Use only the information in the box to answer the questions that follow.

(i) Give the pH of an acid. ................................................................. [1]

(ii) State what is meant by a neutralisation reaction. [1]

(iii) Name the salt produced when sulphuric acid reacts with sodium hydroxide solution. [1]

(iv) Give the word equation for the reaction taking place between sulphuric acid and magnesium. [2]

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

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

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

(v) State how the reaction with magnesium shows that ethanoic acid is a weaker acid than sulphuric acid. [1]
(b) The following table shows the colours of universal indicator at different pH values.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Red</th>
<th>Orange</th>
<th>Yellow</th>
<th>Green</th>
<th>Blue</th>
<th>Navy blue</th>
<th>Purple</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>0-2</td>
<td>3-4</td>
<td>5-6</td>
<td>7</td>
<td>8-9</td>
<td>10-12</td>
<td>13-14</td>
</tr>
</tbody>
</table>

A student is given some common household substances and is asked to find their pH values using universal indicator. His results are shown in the table below.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Colour of universal indicator</th>
<th>pH</th>
<th>Acid, alkali or neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>vinegar</td>
<td>orange</td>
<td>4</td>
<td>alkali</td>
</tr>
<tr>
<td>toothpaste</td>
<td>blue</td>
<td>9</td>
<td>alkali</td>
</tr>
<tr>
<td>water</td>
<td>green</td>
<td>5</td>
<td>neutral</td>
</tr>
<tr>
<td>lemonade</td>
<td>yellow</td>
<td>5</td>
<td>acid</td>
</tr>
</tbody>
</table>

There are two errors in the table. Identify the two errors.

Error 1 .................................................................................................................................

Error 2 .................................................................................................................................
9. A student added sodium hydroxide solution to 25.0 cm³ of hydrochloric acid as shown in the diagram below.

\[ \text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} \]

The titration was carried out three times and the results are shown below.

<table>
<thead>
<tr>
<th>Volume of sodium hydroxide used / cm³</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24.9</td>
<td>25.1</td>
<td>25.0</td>
</tr>
</tbody>
</table>

State what the readings tell you about the relative concentrations of hydrochloric acid and sodium hydroxide solution. Give a reason for your answer. [2]
7. The following table shows the colours of universal indicator at different pH values.

<table>
<thead>
<tr>
<th>Colour</th>
<th>red</th>
<th>orange</th>
<th>yellow</th>
<th>green</th>
<th>blue</th>
<th>navy blue</th>
<th>purple</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH range</td>
<td>0-2</td>
<td>3-4</td>
<td>5-6</td>
<td>7</td>
<td>8-9</td>
<td>10-12</td>
<td>13-14</td>
</tr>
</tbody>
</table>

(a) A solution of coffee turns universal indicator yellow.
   (i) Give the pH range of this solution. [1]
   (ii) State what the pH range tells you about this solution. [1]

---

1. The following table shows the colours of universal indicator at different pH values.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Red</th>
<th>Orange</th>
<th>Yellow</th>
<th>Green</th>
<th>Blue</th>
<th>Navy Blue</th>
<th>Purple</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>0-2</td>
<td>3-4</td>
<td>5-6</td>
<td>7</td>
<td>8-9</td>
<td>10-12</td>
<td>13-14</td>
</tr>
</tbody>
</table>

(i) A solution turns universal indicator purple.
   I. Give the pH range of this solution. [1]
   II. State what the pH range tells us about this solution. [1]

(ii) Limewater is a solution of calcium hydroxide.
     A student noticed that on adding some hydrochloric acid to limewater, a chemical reaction took place, with the temperature increasing by 3°C.
     I. State the word used to describe the type of reaction that takes place between hydrochloric acid and limewater. [1]
     II. State and explain what happened to the pH value of 11 for limewater when excess hydrochloric acid was added. [2]
7. The diagram below shows the apparatus used to find the concentration of a sample of dilute ethanoic acid.

![Diagram of apparatus A and dilute ethanoic acid]

20.0 cm³ sodium hydroxide solution and 3 drops of indicator

The acid was added a little at a time, using apparatus A. The volume of acid needed to change the indicator colour was recorded. The titration was repeated a number of times and an average volume of acid calculated.

(i) Name the piece of apparatus labelled A in the diagram. ........................................... [1]

(ii) State the purpose of the indicator. ........................................................................... [1]
5. Indigestion is caused by excess acid in the stomach. Antacid tablets contain mainly calcium carbonate. The calcium carbonate in an antacid tablet neutralises the excess acid. A group of pupils was asked to carry out an investigation to find

"Which brand of antacid tablet is the best?"

The group was provided with three different tablets, A, B and C, each of equal mass. The apparatus below was used to find out how much dilute hydrochloric acid was needed to react with all the calcium carbonate in each antacid tablet.

Tablet A was crushed and added to 50cm³ of water in a conical flask. Five drops of methyl orange were then added.

The mixture was titrated with dilute hydrochloric acid. The acid was added 0.5cm³ at a time until the methyl orange turned red.

The total volume of acid added was recorded.

This procedure was repeated using tablets B and C.

The results for each tablet are shown below.

<table>
<thead>
<tr>
<th>Tablet</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of acid needed to neutralise all the calcium carbonate in a single tablet (cm³)</td>
<td>12.5</td>
<td>13.5</td>
<td>11.0</td>
</tr>
</tbody>
</table>
(a) Choose from the box above the name of apparatus A in the diagram.

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

[1]

(b) Give the name for substances, such as methyl orange, which have one colour in acids and a different colour in alkalis.

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

[1]

(c) State, giving a reason, how the results could be made more accurate.

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

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

[2]

(d) State, giving a reason, which brand of indigestion tablet is the best.

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

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

[1]
6. The apparatus below can be used to measure the temperature as a neutralisation reaction takes place.

![Apparatus Diagram]

- burette
- hydrochloric acid
- clamp
- thermometer
- 25 cm³ of sodium hydroxide solution
- polystyrene cup

The graphs below show how the temperature changes when acids A and B are added separately to 25 cm³ of sodium hydroxide solution.

Temperature (°C)

![Temperature Graph]

- acid A
- acid B

Volume of acid added (cm³)
(a) Use the graphs opposite to find the

(i) volume of acid required to neutralise the sodium hydroxide solution in both experiments, [1]

(ii) maximum temperature rise for acid B. [1]

(b) State which acid, A or B, is stronger and give a reason for your answer. [1]

Stronger acid

Reason

(c) Describe how an indicator could be used to find the exact volume of acid needed for neutralisation. [3]
8. The diagram shows the apparatus that was used to find the volume of hydrochloric acid needed to neutralise 25.0 cm$^3$ of sodium hydroxide solution.

The balanced equation for the reaction between sodium hydroxide and hydrochloric acid is as follows.

\[ \text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} \]

The acid was added slowly from the burette. The volume of acid needed to change the indicator colour was recorded.

The titration was carried out four times and the volume of acid added each time was recorded in the table below.

<table>
<thead>
<tr>
<th>Run</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of hydrochloric acid (cm$^3$)</td>
<td>33.5</td>
<td>29.5</td>
<td>29.6</td>
<td>29.4</td>
</tr>
</tbody>
</table>
(a) State why an indicator was used in this experiment.

(b) State whether the acid or the alkali is the more concentrated. Give a reason for your answer.

(c)(i) Calculate the mean volume of hydrochloric acid needed to neutralise 25.0 cm$^3$ of the sodium hydroxide solution.

\[
\text{Mean} = \text{cm}^3
\]

(ii) Using all the information provided and your mean volume, describe how a pure sample of sodium chloride crystals could be made.
4. (a) The following table shows the colours of universal indicator at different pH values.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Red</th>
<th>Orange</th>
<th>Yellow</th>
<th>Green</th>
<th>Blue</th>
<th>Navy Blue</th>
<th>Purple</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>0 - 2</td>
<td>3 - 4</td>
<td>5 - 6</td>
<td>7</td>
<td>8 - 9</td>
<td>10 - 12</td>
<td>13 - 14</td>
</tr>
</tbody>
</table>

Ethanoic acid solution turns universal indicator orange.

Give the pH range of this solution. [1]

(b) Two experiments were carried out to investigate the temperature rise when acids and alkalis react. 100 cm$^3$ of two acids, dilute ethanoic acid and dilute hydrochloric acid, were added separately, 10 cm$^3$ at a time, to 100 cm$^3$ of sodium hydroxide solution. After each addition of acid, the temperature was measured and recorded. All the solutions were of the same concentration.

The table below shows the results.

<table>
<thead>
<tr>
<th>Volume of acid added / cm$^3$</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature rise using hydrochloric acid / °C</td>
<td>21.0</td>
<td>22.8</td>
<td>24.2</td>
<td>25.4</td>
<td>26.4</td>
<td>27.0</td>
<td>26.7</td>
<td>26.2</td>
<td>25.6</td>
</tr>
<tr>
<td>Temperature rise using ethanoic acid / °C</td>
<td>21.0</td>
<td>22.6</td>
<td>23.8</td>
<td>24.8</td>
<td>25.6</td>
<td>26.0</td>
<td>25.9</td>
<td>25.5</td>
<td>25.0</td>
</tr>
</tbody>
</table>

(i) Plot the results for ethanoic acid on the grid opposite and draw a curve of best fit. The curve for hydrochloric acid has been done for you. [3]
(ii) Use the graph to give the

I. temperature of both acids at the start of the experiment, \( \ldots \ldots ^\circ C \) [1]

II. volume of both acids needed to neutralise the sodium hydroxide solution.

\( \ldots \ldots \) cm\(^3\) [1]

(iii) Explain why the temperature increase is higher for hydrochloric acid than for ethanoic acid. [1]
(b) Two experiments were carried out to investigate the volume of carbon dioxide given off when sodium carbonate reacted with two acids. 50 cm$^3$ of two acids, ethanoic acid and sulphuric acid, both of equal concentrations were added separately to the same mass of sodium carbonate powder. The total volume of carbon dioxide given off was recorded every 10 seconds in the results table below.

<table>
<thead>
<tr>
<th>Time / seconds</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of carbon dioxide from ethanoic acid / cm$^3$</td>
<td>0</td>
<td>15</td>
<td>27</td>
<td>37</td>
<td>44</td>
<td>49</td>
<td>50</td>
</tr>
<tr>
<td>Volume of carbon dioxide from sulphuric acid / cm$^3$</td>
<td>0</td>
<td>25</td>
<td>40</td>
<td>48</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

(i) Using the table above, plot the results for the ethanoic acid on the grid below and draw the curve of best fit.

The curve for sulphuric acid has been done for you. [3]

(ii) I. Use the graph to give the volume of gas given off when both reactions are complete.

........................... cm$^3$ [1]

II. State which acid reacted more quickly with the sodium carbonate and give a reason for your answer. [2]
1. The following table shows the colours of universal indicator at different pH values.

<table>
<thead>
<tr>
<th>Colour</th>
<th>red</th>
<th>orange</th>
<th>yellow</th>
<th>green</th>
<th>blue</th>
<th>navy blue</th>
<th>purple</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH range</td>
<td>0-2</td>
<td>3-4</td>
<td>5-6</td>
<td>7</td>
<td>8-9</td>
<td>10-12</td>
<td>13-14</td>
</tr>
</tbody>
</table>

(a) A solution of coffee turns universal indicator yellow.

(i) Give the pH range of this solution. ..........................................

(ii) State what the pH range tells you about this solution. ................ [1]

(b) Ethanoic acid turns universal indicator orange and sulphuric acid turns it red. State what this information tells you about the relative strengths of the two acids. .................................................. [1]

(c) An excess of the strong alkali, sodium hydroxide, was added to a small amount of sulphuric acid containing some universal indicator. State what would happen to the pH of the solution and give the final colour of the universal indicator. ................ [2]
4. (a) The following table shows the colours of universal indicator at different pH values.

<table>
<thead>
<tr>
<th>Colour</th>
<th>red</th>
<th>orange</th>
<th>yellow</th>
<th>green</th>
<th>blue</th>
<th>navy blue</th>
<th>purple</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>0-2</td>
<td>3-4</td>
<td>5-6</td>
<td>7</td>
<td>8-9</td>
<td>10-12</td>
<td>13-14</td>
</tr>
</tbody>
</table>

Universal indicator solution was put into separate solutions of sulphuric acid and ethanoic acid.

Give the indicator colour you would expect in each acid and give the reason for your choices.

Indicator colour in sulphuric acid

Indicator colour in ethanoic acid

(b) Two experiments were carried out to investigate the temperature rise when acids and alkalis react. 80 cm³ of dilute hydrochloric acid was added, 10 cm³ at a time, to 100 cm³ of sodium hydroxide solution and the temperature recorded after each addition. The same process was repeated with 80 cm³ of dilute ethanoic acid.

The table below shows the results.

<table>
<thead>
<tr>
<th>Volume of acid added/cm³</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature using hydrochloric acid/°C</td>
<td>21.0</td>
<td>22.8</td>
<td>24.2</td>
<td>25.4</td>
<td>26.4</td>
<td>27.0</td>
<td>26.7</td>
<td>26.2</td>
<td>25.6</td>
</tr>
<tr>
<td>Temperature using ethanoic acid/°C</td>
<td>21.0</td>
<td>22.6</td>
<td>23.8</td>
<td>24.8</td>
<td>25.6</td>
<td>26.0</td>
<td>25.9</td>
<td>25.5</td>
<td>25.0</td>
</tr>
</tbody>
</table>
(i) Plot the results for ethanoic acid on the grid below and draw a curve of best fit. The curve for hydrochloric acid has already been plotted. [3]

(ii) If a piece of universal indicator paper was placed in the flask when exactly 50 cm$^3$ of hydrochloric acid had been added, state the indicator colour you would expect to see. Give the reason for your choice. [2]

*Colour* .................................................................

*Reason* ..................................................................................
(a) The flow diagram below shows some reactions of ethanoic acid, CH₃COOH.

![Diagram showing reactions of ethanoic acid]

(i) Name white solid A. ................................................................. [1]

(ii) Name colourless solution B. ..................................................... [1]

(b) Dilute ethanoic acid reacts with magnesium less vigorously than dilute sulfuric acid of equal concentration.

Give the reason for this difference in behaviour. ................................................................. [1]
Describe the similarities in the reactions of ethanoic acid and sulfuric acid with metals, carbonates and bases. Describe and explain any differences observed. You should include relevant equations in your answer.
Acids, Bases and Salts, 2

Q1. (a) Citric acid produces hydrogen ions in aqueous solution.

These ions can be represented as H⁺(aq).

Complete this sentence.

The (aq) means that the acid has been dissolved in .................................................. .

(b) Citric acid is a weak acid.

Draw a ring around the correct answer to complete the sentence.

<table>
<thead>
<tr>
<th>The word weak means that the acid</th>
<th>has a low boiling point.</th>
</tr>
</thead>
<tbody>
<tr>
<td>is dilute.</td>
<td></td>
</tr>
<tr>
<td>is partially ionised in water.</td>
<td></td>
</tr>
</tbody>
</table>

(c) A student measured the pH of four acids, A, B, C and D.

The acids were the same concentration. The same quantity of magnesium ribbon was added to each of the acids. The volume of gas produced after 5 minutes was recorded.

The results are shown in the table.

<table>
<thead>
<tr>
<th>Acid</th>
<th>pH</th>
<th>Volume of gas in cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

(i) Use the results to arrange the acids, A, B, C and D in order of decreasing acid strength.

Most acidic ............................................................... Least acidic.

(d) When acids react with alkalis, the hydrogen ions from the acid react with the hydroxide ions from the alkali.

(i) Which one of the following represents the formula of a hydroxide ion?
Q2. Acids and bases are commonly found around the home.

(a) Baking powder contains sodium hydrogencarbonate mixed with an acid.

(i) When water is added, the baking powder releases carbon dioxide. How could you test the gas to show that it is carbon dioxide?

Test ..................................................................................................................................................

Result of test ..................................................................................................................................

Q3. Salts can be prepared by the reaction of acids with alkalis.

(a) (i) The reactions of acids with alkalis can be represented by the equation below. Choose a substance from the box to complete the equation.

\[
\text{acid} + \text{alkali} \rightarrow \text{salt} + \text{..........................................................}
\]

(ii) Draw a ring around the word which best describes the reaction.

displacement  neutralisation  oxidation  reduction

(b) Sodium sulphate is an important salt.

The table gives a list of some substances.

Put a tick (✓) next to the names of the acid and the alkali that would react to make sodium sulphate.

<table>
<thead>
<tr>
<th>Substances</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td></td>
</tr>
<tr>
<td>Nitric acid</td>
<td></td>
</tr>
<tr>
<td>Potassium sulphate</td>
<td></td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td></td>
</tr>
<tr>
<td>Sodium nitrate</td>
<td></td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td></td>
</tr>
</tbody>
</table>
Making Salts.

Q1. The information in the box is about the preparation of copper sulphate crystals.

Step 1 Add a small amount of black copper oxide to some hot dilute sulphuric acid, and stir.
Step 2 Keep adding copper oxide until it is in excess.
Step 3 Remove the excess copper oxide to leave blue copper sulphate solution.
Step 4 Evaporate the copper sulphate solution until it is saturated.
Step 5 Leave the saturated solution of copper sulphate to cool. Blue copper sulphate crystals form on cooling.
Step 6 Remove the crystals from the solution remaining.
Step 7 Dry the blue crystals on a piece of filter paper.

(i) Suggest a reason for using excess copper oxide in Step 2.
..............................................................................................................................................
..............................................................................................................................................

(ii) Suggest how the excess copper oxide can be removed from the solution in Step 3.
..............................................................................................................................................
..............................................................................................................................................

(iii) What is meant by the term saturated solution?
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................

(iv) Why do crystals form when a hot saturated solution cools?
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................

(v) Suggest why the blue crystals are dried in Step 7 using filter paper instead of by heating.
..............................................................................................................................................
..............................................................................................................................................
A titration was used to find the concentration of the sulphuric acid solution in the beaker.

**Stage 1** 25.0 cm$^3$ of the sulphuric acid solution was added to a flask using a pipette.

**Stage 2** A solution of an alkali was added to the acid until the solution was neutral. The volume of the alkali was noted.

(a) What would be the pH of the sulphuric acid solution?

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

(1)

(b) Why was a pipette used instead of a measuring cylinder in **Stage 1**?

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

(1)

(c) Name the apparatus labelled X which is used to add the alkali in **Stage 2**.

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

(1)

(d) Name an alkali that could be used in **Stage 2**.

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

(1)

(e) (i) Name an indicator that you could use to find out when the solution was neutral.

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

(1)

(ii) How would you know that the solution was neutral?

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

(1)

Total = 12 marks