19 Hydrochloric acid is used to clean metals.
   The acid reacts with the oxide layer on the surface of the metal, forming a salt and water.
   Which word describes the metal oxide?
   A alloy
   B base
   C element
   D indicator

20 Which substance reacts with calcium to form a salt?
   A hydrochloric acid
   B oxygen
   C sodium hydroxide
   D water

21 The incomplete equation shows a reaction.
   \[ \text{CuCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{products} \]
   What are the products of this reaction?
   A copper(II) oxide, sulphur dioxide, hydrogen
   B copper(II) oxide, sulphur dioxide, water
   C copper(II) sulphate, carbon dioxide, hydrogen
   D copper(II) sulphate, carbon dioxide, water

19 Aqueous lead(II) nitrate is added to a solution containing iodide ions. Lead(II) iodide is formed.
   Which type of reaction takes place?
   A neutralisation
   B oxidation
   C precipitation
   D reduction
20 Which element reacts with dilute sulphuric acid to produce hydrogen?
   A  carbon
   B  chlorine
   C  copper
   D  zinc

21 For which pH change is there the largest increase in acidity?

<table>
<thead>
<tr>
<th></th>
<th>initial pH</th>
<th>final pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

03s1

16 When hydrated copper(II) sulphate is heated in the apparatus shown, solid X and liquid Y are produced.

Which changes are noticed when liquid Y is added to cold solid X?

<table>
<thead>
<tr>
<th>colour change</th>
<th>heat change</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>blue to white, heat given out</td>
</tr>
<tr>
<td>B</td>
<td>blue to white, heat taken in</td>
</tr>
<tr>
<td>C</td>
<td>white to blue, heat given out</td>
</tr>
<tr>
<td>D</td>
<td>white to blue, heat taken in</td>
</tr>
</tbody>
</table>
19 Which substance does not form copper(II) sulphate with warm, dilute sulphuric acid?
   A  copper
   B  copper(II) carbonate
   C  copper(II) hydroxide
   D  copper(II) oxide

20 Which test method and gas are correctly linked?

<table>
<thead>
<tr>
<th>test method</th>
<th>gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  a lighted splint</td>
<td>oxygen</td>
</tr>
<tr>
<td>B  a glowing splint</td>
<td>hydrogen</td>
</tr>
<tr>
<td>C  damp litmus paper</td>
<td>chlorine</td>
</tr>
<tr>
<td>D  limewater</td>
<td>ammonia</td>
</tr>
</tbody>
</table>

21 Water is added to a test-tube containing dilute sulphuric acid of pH 4.

What could be the pH of the resulting solution?
   A  8  B  6  C  4  D  2

15 Potassium nitrate is a salt and dissolves in water in an endothermic process.

What happens to the temperature and pH of the water as the salt dissolves?

<table>
<thead>
<tr>
<th>temperature increases</th>
<th>pH falls</th>
</tr>
</thead>
<tbody>
<tr>
<td>A ✓</td>
<td>✓</td>
</tr>
<tr>
<td>B ✓</td>
<td>×</td>
</tr>
<tr>
<td>C ×</td>
<td>✓</td>
</tr>
<tr>
<td>D ×</td>
<td>×</td>
</tr>
</tbody>
</table>

19 Which two processes are involved in the preparation of magnesium sulphate crystals from dilute sulphuric acid and an excess of magnesium oxide?
   A  decomposition and filtration
   B  decomposition and oxidation
   C  neutralisation and filtration
   D  neutralisation and oxidation
20 The diagram shows the result of testing an aqueous solution Z.

Which ion is present in solution Z?
A  carbonate
B  chloride
C  nitrate
D  sulphate

21 The pH values of four solutions are shown.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>Q</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mixing combinations of these solutions can give a solution of pH 6.

Which combination of solutions could not do this?
A  P and R
B  P and S
C  Q and R
D  R and S
19 An aqueous solution contains either aluminium sulphate or zinc sulphate. Which aqueous reagent can be used to confirm which salt is present?

A ammonia
B barium chloride
C sodium hydroxide
D sulphuric acid

20 Compound X
- does not dissolve in water,
- does not react with water,
- is used to control soil acidity.

What is X?

A calcium carbonate
B calcium chloride
C calcium hydroxide
D calcium oxide

21 Aqueous sodium hydroxide is added to two different solutions with the results shown.

![Reaction Diagram]

green precipitate formed
light blue precipitate formed

Which cation is present in X and in Y?

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ammonium</td>
<td>iron(II)</td>
</tr>
<tr>
<td>B</td>
<td>copper(II)</td>
<td>ammonium</td>
</tr>
<tr>
<td>C</td>
<td>iron(II)</td>
<td>copper(II)</td>
</tr>
<tr>
<td>D</td>
<td>iron(II)</td>
<td>ammonium</td>
</tr>
</tbody>
</table>
The pH of some aqueous sodium hydroxide is measured. The solution is then distilled as shown.

How do the pH values of the distillate and of the solution left in the flask compare with the original?

<table>
<thead>
<tr>
<th></th>
<th>pH of the distillate</th>
<th>pH of the solution left in the flask</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>higher</td>
<td>higher</td>
</tr>
<tr>
<td>B</td>
<td>higher</td>
<td>lower</td>
</tr>
<tr>
<td>C</td>
<td>lower</td>
<td>higher</td>
</tr>
<tr>
<td>D</td>
<td>lower</td>
<td>lower</td>
</tr>
</tbody>
</table>
19 Aqueous ammonia is added to a solution of a metal sulphate.

A green precipitate that is insoluble in excess of the aqueous ammonia forms.

Which metal ion is present?
A $\text{Ca}^{2+}$  B $\text{Cu}^{2+}$  C $\text{Fe}^{3+}$  D $\text{Fe}^{2+}$

20 The chart shows the colour ranges of four different indicators.

Which indicator is blue in an acidic solution?

<table>
<thead>
<tr>
<th>indicator</th>
<th>pH value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14</td>
</tr>
<tr>
<td>A</td>
<td>yellow blue</td>
</tr>
<tr>
<td>B</td>
<td>red blue yellow</td>
</tr>
<tr>
<td>C</td>
<td>red blue</td>
</tr>
<tr>
<td>D</td>
<td>colourless blue</td>
</tr>
</tbody>
</table>

21 An ion $X$ in solution is identified as shown.

![Diagram](image)

What is ion $X$?
A $\text{Al}^{3+} \text{(aq)}$  B $\text{NH}_4^+ \text{(aq)}$  C $\text{NO}_3^- \text{(aq)}$  D $\text{SO}_4^{2-} \text{(aq)}$
18 What is the colour of liquid bromine and of the aqueous bromide ion?

<table>
<thead>
<tr>
<th></th>
<th>bromine</th>
<th>bromide ion</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>red-brown</td>
<td>red-brown</td>
</tr>
<tr>
<td>B</td>
<td>red-brown</td>
<td>colourless</td>
</tr>
<tr>
<td>C</td>
<td>yellow-green</td>
<td>yellow-green</td>
</tr>
<tr>
<td>D</td>
<td>yellow-green</td>
<td>colourless</td>
</tr>
</tbody>
</table>

19 Which property does hydrochloric acid have?

A. It gives a pale blue precipitate with aqueous copper(II) sulphate.
B. It gives a white precipitate with aqueous barium nitrate.
C. It releases ammonia from aqueous ammonium sulphate.
D. It releases hydrogen with zinc powder.

20 Hydrochloric acid is used to clean a metal surface by removing the oxide layer on the metal.

This is because hydrochloric acid has a ....X.... pH and the metal oxide is ....Y.....

What are X and Y?

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>high</td>
<td>acidic</td>
</tr>
<tr>
<td>B</td>
<td>high</td>
<td>basic</td>
</tr>
<tr>
<td>C</td>
<td>low</td>
<td>acidic</td>
</tr>
<tr>
<td>D</td>
<td>low</td>
<td>basic</td>
</tr>
</tbody>
</table>
21 The apparatus shown can be used to prepare aqueous copper(II) sulphate.

What are substances X and Y?

<table>
<thead>
<tr>
<th></th>
<th>substance X</th>
<th>substance Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>copper</td>
<td>iron(II) sulphate</td>
</tr>
<tr>
<td>B</td>
<td>copper(II) chloride</td>
<td>sulphuric acid</td>
</tr>
<tr>
<td>C</td>
<td>copper(II) oxide</td>
<td>sulphuric acid</td>
</tr>
<tr>
<td>D</td>
<td>sulphur</td>
<td>copper(II) chloride</td>
</tr>
</tbody>
</table>

22 In the experiment shown, the dilute sulphuric acid is run into the flask of aqueous barium hydroxide until the reaction is complete.

Which processes occur in this reaction?

<table>
<thead>
<tr>
<th></th>
<th>neutralisation</th>
<th>precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>C</td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>
7 Bottles of sodium hydroxide, sodium chloride and sugar have lost their labels.

Students test a sample from each bottle. Their results are shown in the table.

<table>
<thead>
<tr>
<th>bottle</th>
<th>addition of water</th>
<th>conductivity of solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>forms an alkaline solution</td>
<td>conducts electricity</td>
</tr>
<tr>
<td>2</td>
<td>forms a neutral solution</td>
<td>conducts electricity</td>
</tr>
<tr>
<td>3</td>
<td>forms a neutral solution</td>
<td>does not conduct electricity</td>
</tr>
</tbody>
</table>

What are the correct labels for each bottle?

<table>
<thead>
<tr>
<th></th>
<th>bottle 1</th>
<th>bottle 2</th>
<th>bottle 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>sodium hydroxide</td>
<td>sodium chloride</td>
<td>sugar</td>
</tr>
<tr>
<td>B</td>
<td>sodium hydroxide</td>
<td>sugar</td>
<td>sodium hydroxide</td>
</tr>
<tr>
<td>C</td>
<td>sodium chloride</td>
<td>sugar</td>
<td>sodium hydroxide</td>
</tr>
<tr>
<td>D</td>
<td>sugar</td>
<td>sodium hydroxide</td>
<td>sodium chloride</td>
</tr>
</tbody>
</table>

16 An excess of acid in the stomach causes indigestion that can be cured by an anti-indigestion tablet.

What should the tablet contain to decrease the acidity?
A an acidic substance
B an alkaline substance
C a neutral substance
D Universal Indicator

17 A solution is made by adding sodium oxide to water.

Which pH change can occur?

<table>
<thead>
<tr>
<th></th>
<th>pH change</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 → 7</td>
</tr>
<tr>
<td>B</td>
<td>7 → 1</td>
</tr>
<tr>
<td>C</td>
<td>7 → 12</td>
</tr>
<tr>
<td>D</td>
<td>12 → 7</td>
</tr>
</tbody>
</table>

18 Which element has an oxide that forms a salt with an alkali?
A N  B Na  C Ne  D Ni
The diagrams show three experiments.

In which experiments is ammonia formed?

**A** 1 only  **B** 2 only  **C** 3 only  **D** 1, 2 and 3

Barium hydroxide is an alkali. It reacts with hydrochloric acid.

What happens to the pH of a solution of hydrochloric acid as an excess of aqueous barium hydroxide is added?

**A** The pH decreases from 14 but becomes constant at 7.

**B** The pH decreases from 14 to about 1.

**C** The pH increases from 1 but becomes constant at 7.

**D** The pH increases from 1 to about 14.
33 The diagram shows an experiment.

What is the name of the gas and the final colour of the litmus paper?

<table>
<thead>
<tr>
<th></th>
<th>gas</th>
<th>colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ammonia</td>
<td>blue</td>
</tr>
<tr>
<td>B</td>
<td>ammonia</td>
<td>red</td>
</tr>
<tr>
<td>C</td>
<td>chlorine</td>
<td>white</td>
</tr>
<tr>
<td>D</td>
<td>chlorine</td>
<td>red</td>
</tr>
</tbody>
</table>

34 The diagram shows the pH values of the soil in X and Y, two parts of the garden of a house.

The house owner wishes to use lime to neutralise the soil in one part of the garden.

To which part should the lime be added, and why?

<table>
<thead>
<tr>
<th>part of garden</th>
<th>because lime is</th>
</tr>
</thead>
<tbody>
<tr>
<td>A X</td>
<td>acidic</td>
</tr>
<tr>
<td>B X</td>
<td>basic</td>
</tr>
<tr>
<td>C Y</td>
<td>acidic</td>
</tr>
<tr>
<td>D Y</td>
<td>basic</td>
</tr>
</tbody>
</table>
17 Acids react with bases, carbonates and metals.

Which of these reactions produce a gas?

<table>
<thead>
<tr>
<th>reaction of acid with a</th>
<th>base</th>
<th>carbonate</th>
<th>metal</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>C</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
</tbody>
</table>

18 Which properties does an acid have?

1 reacts with ammonium sulphate to form ammonia
2 turns red litmus blue

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>C</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

19 The diagrams show two experiments, one to make barium chloride and the other to make barium sulphate.

In each experiment, the acid is run into the conical flask until the resulting liquid has pH7.

What are the next steps to obtain samples of the solid salts?

<table>
<thead>
<tr>
<th>barium chloride</th>
<th>barium sulphate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>crystallisation</td>
</tr>
<tr>
<td>B</td>
<td>crystallisation</td>
</tr>
<tr>
<td>C</td>
<td>filtration</td>
</tr>
<tr>
<td>D</td>
<td>filtration</td>
</tr>
</tbody>
</table>
20 Which piece of equipment can be used to show that a gas is hydrogen?

A  damp litmus paper

B  splint

C  splint

D  limewater

18 Aqueous sodium hydroxide and aqueous ammonia each give a white precipitate when added to aqueous zinc sulphate.

What happens when an excess of each of these reagents is added?

<table>
<thead>
<tr>
<th></th>
<th>excess NaOH(aq)</th>
<th>excess NH₃(aq)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>precipitate dissolves</td>
<td>precipitate dissolves</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>precipitate dissolves</td>
<td>precipitate does not dissolve</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>precipitate does not dissolve</td>
<td>precipitate dissolves</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>precipitate does not dissolve</td>
<td>precipitate does not dissolve</td>
</tr>
</tbody>
</table>
19  Aqueous sodium hydroxide is added to two different solutions with the results shown.

\[
\begin{align*}
&X & & Y \\
&\text{green precipitate formed} & \text{light blue precipitate formed}
\end{align*}
\]

What are the cations present in X and Y?

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>copper(II)</td>
<td>iron(II)</td>
</tr>
<tr>
<td>B</td>
<td>copper(II)</td>
<td>iron(III)</td>
</tr>
<tr>
<td>C</td>
<td>iron(II)</td>
<td>copper(II)</td>
</tr>
<tr>
<td>D</td>
<td>iron(III)</td>
<td>copper(II)</td>
</tr>
</tbody>
</table>

20  In which experiment does the limewater not turn milky?

A

\[
\begin{align*}
\text{acid} & \quad \text{magnesium carbonate} \\
\text{limewater} &
\end{align*}
\]

B

\[
\begin{align*}
\text{ethanol} & \\
\text{limewater} & \quad \text{suction pump}
\end{align*}
\]

C

\[
\begin{align*}
\text{acid} & \quad \text{iron filings} \\
\text{limewater} &
\end{align*}
\]

D
21 Two indicators, bromophenol blue and Congo red, show the following colours in acidic solution and in alkaline solutions.

<table>
<thead>
<tr>
<th>indicator</th>
<th>acid</th>
<th>alkali</th>
</tr>
</thead>
<tbody>
<tr>
<td>bromophenol blue</td>
<td>yellow</td>
<td>blue</td>
</tr>
<tr>
<td>Congo red</td>
<td>violet</td>
<td>red</td>
</tr>
</tbody>
</table>

A few drops of each indicator are added to separate samples of a solution of pH 2. What are the colours of the indicators in this solution?

<table>
<thead>
<tr>
<th></th>
<th>in a solution of pH 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>bromophenol blue is</td>
<td>Congo red is</td>
</tr>
<tr>
<td>A</td>
<td>blue</td>
</tr>
<tr>
<td>B</td>
<td>blue</td>
</tr>
<tr>
<td>C</td>
<td>yellow</td>
</tr>
<tr>
<td>D</td>
<td>yellow</td>
</tr>
</tbody>
</table>

22 Aqueous lead(II) nitrate is added to a solution containing iodide ions. Lead(II) iodide is formed. Which type of reaction takes place?

A. neutralisation
B. oxidation
C. precipitation
D. reduction
Dilute sulphuric acid is added to a mixture of copper, magnesium and zinc in a beaker. The beaker is left for about 10 minutes and its contents are then filtered.

What does the filtrate contain?

A copper(II) sulphate, magnesium sulphate and zinc sulphate
B copper(II) sulphate and zinc sulphate only
C magnesium sulphate and zinc sulphate only
D magnesium sulphate only

Gas X is passed into water as shown.

The pH of the water changes from 7 to 10.

What is gas X?

A ammonia
B carbon dioxide
C nitrogen
D sulphur dioxide

The diagram shows an experiment.

Which terms describe the experiment?

<table>
<thead>
<tr>
<th></th>
<th>endothermic</th>
<th>neutralisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>B</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>C</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>D</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>
21. Which statement describes a test for carbon dioxide gas?

A. It bleaches damp litmus paper.
B. It relights a glowing splint.
C. It turns cobalt(II) chloride paper pink.
D. It turns limewater cloudy.

22. A solution of zinc sulphate can be made by adding an excess either of zinc carbonate or of zinc hydroxide to dilute sulphuric acid.

In which forms are these zinc compounds added to the acid?

<table>
<thead>
<tr>
<th></th>
<th>zinc carbonate</th>
<th>zinc hydroxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>aqueous</td>
<td>aqueous</td>
</tr>
<tr>
<td>B</td>
<td>aqueous</td>
<td>solid</td>
</tr>
<tr>
<td>C</td>
<td>solid</td>
<td>aqueous</td>
</tr>
<tr>
<td>D</td>
<td>solid</td>
<td>solid</td>
</tr>
</tbody>
</table>

20. Dilute hydrochloric acid is added to aqueous barium nitrate in a test-tube.

What happens?

<table>
<thead>
<tr>
<th></th>
<th>the pH of the liquid in the test-tube</th>
<th>a precipitate forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>decreases</td>
<td>yes</td>
</tr>
<tr>
<td>B</td>
<td>decreases</td>
<td>no</td>
</tr>
<tr>
<td>C</td>
<td>increases</td>
<td>yes</td>
</tr>
<tr>
<td>D</td>
<td>increases</td>
<td>no</td>
</tr>
</tbody>
</table>

3. An aqueous solution contains barium iodide.

It is possible to obtain a solution that contains $\text{Ba}^{2+}(\text{aq})$ but no $\text{I}^-(\text{aq})$ by adding ......1...... until no more ......2...... precipitate forms.

Which words correctly complete gaps 1 and 2?

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>aqueous lead(II) nitrate</td>
<td>white</td>
</tr>
<tr>
<td>B</td>
<td>aqueous lead(II) nitrate</td>
<td>yellow</td>
</tr>
<tr>
<td>C</td>
<td>dilute sulphuric acid</td>
<td>white</td>
</tr>
<tr>
<td>D</td>
<td>dilute sulphuric acid</td>
<td>yellow</td>
</tr>
</tbody>
</table>
21 A colourless liquid in an unlabelled bottle is tested as shown.

- Litmus paper turns red.
- Magnesium ribbon fizzed.
- Reaction with aqueous barium nitrate produced a white precipitate.

What is the colourless liquid?
A  aqueous sodium hydroxide
B  aqueous sodium sulphate
C  dilute hydrochloric acid
D  dilute sulphuric acid

22 The diagrams show two experiments.

<table>
<thead>
<tr>
<th></th>
<th>experiment 1</th>
<th>experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>aqueous ammonium</td>
<td>blue → red</td>
<td>both pieces</td>
</tr>
<tr>
<td>chloride</td>
<td></td>
<td>bleached</td>
</tr>
<tr>
<td>+</td>
<td></td>
<td>no change</td>
</tr>
<tr>
<td>aqueous sodium</td>
<td>red → blue</td>
<td>both pieces</td>
</tr>
<tr>
<td>hydroxide</td>
<td></td>
<td>bleached</td>
</tr>
<tr>
<td></td>
<td></td>
<td>no change</td>
</tr>
</tbody>
</table>

What happens to the pieces of litmus paper?

<table>
<thead>
<tr>
<th></th>
<th>experiment 1</th>
<th>experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>blue → red</td>
<td>both pieces</td>
</tr>
<tr>
<td>B</td>
<td>blue → red</td>
<td>no change</td>
</tr>
<tr>
<td>C</td>
<td>red → blue</td>
<td>both pieces</td>
</tr>
<tr>
<td>D</td>
<td>red → blue</td>
<td>no change</td>
</tr>
</tbody>
</table>

23 Which substances react with dilute sulphuric acid to form a salt?

<table>
<thead>
<tr>
<th></th>
<th>magnesium</th>
<th>magnesium oxide</th>
<th>magnesium carbonate</th>
<th>magnesium chloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>C</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
20 Aqueous sodium hydroxide is added to a solution of a salt. A blue precipitate is formed which does not dissolve in excess.

Aluminium foil is added to the mixture and the mixture is warmed. A gas is produced that turns damp red litmus paper blue.

What is the name of the salt?

A ammonium nitrate
B ammonium sulfate
C copper(II) nitrate
D copper(II) sulfate

21 The graph shows how the pH of soil in a field changed over time.

At which point was the soil neutral?

22 An element E is burned in air. A white solid oxide is formed.

The oxide is tested with damp red litmus paper. The paper turns blue.

What is element E?

A calcium
B carbon
C iodine
D sulfur
23 Some reactions of a substance, R, are shown in the diagram.

Substance R reacts with magnesium to form hydrogen, sodium carbonate to form carbon dioxide, and copper(II) oxide to form copper(II) sulfate.

What type of substance is R?
A an acid
B a base
C an element
D a salt

16 When an acid is added to an alkali the temperature rises.

Which words describe this reaction?
A decomposition and endothermic
B decomposition and exothermic
C neutralisation and endothermic
D neutralisation and exothermic

20 An aqueous solution Y contains both barium ions and silver ions.

In separate experiments, dilute sulfuric acid and dilute hydrochloric acid are added to solution Y.

Which of these acids causes a precipitate to form in solution Y?

<table>
<thead>
<tr>
<th></th>
<th>dilute sulfuric acid</th>
<th>dilute hydrochloric acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>C</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

21 The diagram shows the pH values of four solutions.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which of these solutions are alkaline?
A P only
B P and Q only
C Q, R and S only
D R and S only

WWW.SmashingChemistry.com
23 Salts can be prepared by reacting a dilute acid
   1 with a metal;
   2 with a base;
   3 with a carbonate.

Which methods could be used to prepare copper(II) chloride?

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3

19 Aqueous sodium hydroxide is added to a solid, X, and the mixture is heated.

A green precipitate is formed and an alkaline gas is given off.

Which ions are present in X?

A $\text{NH}_4^+$ and $\text{Fe}^{2+}$
B $\text{NH}_4^+$ and $\text{Fe}^{3+}$
C $\text{OH}^-$ and $\text{Fe}^{2+}$
D $\text{OH}^-$ and $\text{Fe}^{3+}$

20 An aqueous solution of the organic compound methylamine has a pH greater than 7.

Which statement about methylamine is correct?

A It neutralises an aqueous solution of sodium hydroxide.
B It reacts with copper(II) carbonate to give carbon dioxide.
C It reacts with hydrochloric acid to form a salt.
D It turns blue litmus red.

21 The positions in the Periodic Table of four elements are shown.

Which element is most likely to form an acidic oxide?
22 An excess of copper(II) oxide is added to dilute sulfuric acid to make crystals of hydrated copper(II) sulfate.

The processes listed may be used to obtain crystals of hydrated copper(II) sulfate.

1. Concentrate the resulting solution
2. Filter
3. Heat the crystals
4. Wash the crystals

Which processes are needed and in which order?

A  1, 2, 3 and 4
B  1, 2, 4 and 3
C  2, 1, 2 and 3
D  2, 1, 2 and 4

19 Some barium iodide is dissolved in water.

Aqueous lead(II) nitrate is added to the solution until no more precipitate forms.

This precipitate, X, is filtered off.

Dilute sulfuric acid is added to the filtrate and another precipitate, Y, forms.

What are the colours of precipitates X and Y?

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>white</td>
<td>white</td>
</tr>
<tr>
<td>B</td>
<td>white</td>
<td>yellow</td>
</tr>
<tr>
<td>C</td>
<td>yellow</td>
<td>white</td>
</tr>
<tr>
<td>D</td>
<td>yellow</td>
<td>yellow</td>
</tr>
</tbody>
</table>

20 Which reaction will result in a decrease in pH?

A adding calcium hydroxide to acid soil
B adding citric acid to sodium hydrogen carbonate solution
C adding sodium chloride to silver nitrate solution
D adding sodium hydroxide to hydrochloric acid
21 The oxide of element X was added to an acid. It reacted to form a salt and water.

What is the pH of the acid before the reaction and what type of element is X?

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>type of element X</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>greater than 7</td>
<td>metal</td>
</tr>
<tr>
<td>B</td>
<td>greater than 7</td>
<td>non-metal</td>
</tr>
<tr>
<td>C</td>
<td>less than 7</td>
<td>metal</td>
</tr>
<tr>
<td>D</td>
<td>less than 7</td>
<td>non-metal</td>
</tr>
</tbody>
</table>

22 A salt is made by adding an excess of an insoluble metal oxide to an acid.

How can the excess metal oxide be removed?

A chromatography
B crystallisation
C distillation
D filtration

Mark Scheme

02s1

19 B
20 A
21 D

02w1

19 C
20 D
21 D

03s1

16 C
17 A

03s1

19 A

03w1

15 D
03w1
19  C
20  C

05w1
16  B
17  C
18  A

04s1
19  A
20  A

06s1
16  D

04s1
21  C

06s1
31  C

06s1
33  A

06s1
34  D

04w1
30  C

06w1

05s1
17  D
20  A
21  C

07s1
18  D
19  B
20  C

05s1
18  D

07s1
19  C
20  C

05s1
21  C
22  A

07s1
21  D
22  C

05w1
7  A
(b) Zinc oxide is used to make aqueous zinc chloride. This can be used to preserve wood. Describe how this solution could be made.

......................................................................................................................................................................................
......................................................................................................................................................................................
......................................................................................................................................................................................
......................................................................................................................................................................................[3]

01w3

(d) Sulphuric acid is a typical strong acid.

(i) Explain the term strong acid.

......................................................................................................................................................................................[2]

(ii) Write a word equation for the reaction between zinc carbonate and sulphuric acid.

......................................................................................................................................................................................[2]

(iii) Write an equation for the reaction between sodium hydroxide and sulphuric acid.

......................................................................................................................................................................................[2]

(iv) Write an ionic equation for the reaction between magnesium and sulphuric acid.

......................................................................................................................................................................................[2]
2 Fermentation of sugars is one method of making ethanol. Vines produce glucose by photosynthesis. The glucose collects in the grapes which grow in clusters on the vine.

![Green leaves](image)

(a) Vines are attacked by a fungus that ruins the grapes. In 1882 it was discovered that spraying the vines with Bordeaux mixture killed the fungus.

   The fungicide, Bordeaux mixture, contains water, calcium hydroxide and copper(II) sulphate.

   (i) Name the raw material from which calcium hydroxide is made.

   ...........................................................................................................................................[1]

   (ii) The mixture contains four ions. Complete the list of ions.

       Cu²⁺, OH⁻, ...................... and ...................... [2]

   (iii) A different fungicide can be made by the reaction between an excess of aqueous ammonia and a copper(II) salt. Describe the observations for this reaction.

       addition of aqueous ammonia .........................................................................................

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

       then excess aqueous ammonia ......................................................................................[3]
4 Bromine is one of the halogens in Group VII.

(d) Phosphorus tribromide reacts with water to form two acids.

(i) Balance the equation for this reaction.

\[ \text{PBr}_3 + \text{......H}_2\text{O} \longrightarrow \text{......HBr} + \text{H}_3\text{PO}_3 \] \[[1]\]

(ii) Describe by giving essential details how you could show that phosphorous acid, \(\text{H}_3\text{PO}_3\), is a weaker acid than hydrogen bromide.

.........................................................................................................................
.........................................................................................................................
.........................................................................................................................
.........................................................................................................................\[2]\]

(e) Hydrogen bromide is an acid. When it is dissolved in water the following reaction occurs.

\[ \text{HBr} + \text{H}_2\text{O} \longrightarrow \text{H}_3\text{O}^+ + \text{Br}^- \]

(i) Name the particle lost by the hydrogen bromide molecule.

.........................................................................................................................\[1]\]

(ii) What type of reagent is the water molecule in this reaction?

.........................................................................................................................\[1]\]

(b) There are three ways of making salts from sulphuric acid.

*titration* using a burette and indicator

*precipitation* by mixing the solutions and filtering

*neutralisation* of sulphuric acid using an excess of an insoluble base

Complete the following table of salt preparations.

<table>
<thead>
<tr>
<th>method</th>
<th>reactant 1</th>
<th>reactant 2</th>
<th>salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>titration</td>
<td>sulphuric acid</td>
<td></td>
<td>sodium sulphate</td>
</tr>
<tr>
<td>neutralisation</td>
<td>sulphuric acid</td>
<td></td>
<td>zinc sulphate</td>
</tr>
<tr>
<td>precipitation</td>
<td>sulphuric acid</td>
<td></td>
<td>barium sulphate</td>
</tr>
<tr>
<td></td>
<td>sulphuric acid</td>
<td>copper(II) oxide</td>
<td>copper(II) sulphate</td>
</tr>
</tbody>
</table>

[4]
2. Manganese is a transition element. It has more than one valency and the metal and its compounds are catalysts.

(b) It has several oxides, three of which are shown below.
Manganese(II) oxide, which is basic.
Manganese(III) oxide, which is amphoteric.
Manganese(IV) oxide, which is acidic.

(i) Complete the word equation.

\[
\text{manganese(II)} + \text{hydrochloric acid} \rightarrow \text{~~~~~~~~~~~~~~~~~~~~~~~~} + \text{~~~~~~~~~~~~~~~~~~~~~~~~} \text{[2]}
\]

(ii) Which, if any, of these oxides will react with sodium hydroxide?

\[
\text{~~~~~~~~~~~~~~~~~~~~~~~~}[1]
\]

2. Calcium and other minerals are essential for healthy teeth and bones. Tablets can be taken to provide these minerals.

(b) Describe the reactions, if any, of zinc and copper(II) ions with an excess of aqueous sodium hydroxide.

(i) zinc ions

\[
\text{addition of aqueous sodium hydroxide} \text{~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
\]

\[
\text{excess sodium hydroxide} \text{~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
\]

(ii) copper(II) ions

\[
\text{addition of aqueous sodium hydroxide} \text{~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
\]

\[
\text{excess sodium hydroxide} \text{~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}[4]
\]

3. Nitrogen dioxide, oxygen and water react to form dilute nitric acid.
Describe how lead(II) nitrate crystals could be prepared from dilute nitric acid and lead(II) oxide.
(c) Ammonia is a base.

(i) Name a particle that an ammonia molecule can accept from an acid.

(ii) Write an equation for ammonia acting as a base.

(d) Given aqueous solutions, 0.1 mol/dm$^3$, of sodium hydroxide and ammonia, describe how you could show that ammonia is the weaker base.

(ii) To aqueous sulphur dixoide, acidified barium chloride solution is added. The mixture remains clear. When bromine is added, a thick white precipitate forms. What is the white precipitate? Explain why it forms.

(iii) Rock phosphate (calcium phosphate) is obtained by mining. It reacts with concentrated sulphuric acid to form the fertiliser, superphosphate. Predict the formula of each of these phosphates.

<table>
<thead>
<tr>
<th>fertiliser</th>
<th>ions</th>
<th>formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium phosphate</td>
<td>Ca$^{2+}$ and PO$_4^{3-}$</td>
<td></td>
</tr>
<tr>
<td>calcium superphosphate</td>
<td>Ca$^{2+}$ and H$_2$PO$_4^-$</td>
<td></td>
</tr>
</tbody>
</table>

(iv) The ionic equation for the reaction between the phosphate ion and sulphuric acid is shown below.

$$\text{PO}_4^{3-} + 2\text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{PO}_4^- + 2\text{HSO}_4^-$$

Explain why the phosphate ion is described as acting as a base in this reaction.
4 (a) Insoluble compounds are made by precipitation.

(i) Complete the word equation for the preparation of zinc carbonate.

\[ \text{sodium carbonate} \rightarrow \text{zinc carbonate} + \text{[2]} \]

(ii) Complete the following symbol equation.

\[ \text{Pb(NO}_3\text{)}_2 + \text{NaCl} \rightarrow \text{[2]} \]

(iii) Write an ionic equation for the precipitation of the insoluble salt, silver(I) chloride.

\[ \text{[2]} \]

(b) 2.0 cm\(^3\) portions of aqueous sodium hydroxide were added to 4.0 cm\(^3\) of aqueous iron(III) chloride. Both solutions had a concentration of 1.0 mol/dm\(^3\). After each addition, the mixture was stirred, centrifuged and the height of the precipitate of iron(III) hydroxide was measured. The results are shown on the following graph.

(i) Complete the ionic equation for the reaction.

\[ \text{Fe}^{3+} + \text{OH}^- \rightarrow \text{[1]} \]

(ii) On the same grid, sketch the graph that would have been obtained if iron(II) chloride had been used instead of iron(III) chloride? [2]
(iii) If aluminium chloride had been used instead of iron(III) chloride, the shape of the graph would be different. How are the shapes of these two graphs different and why?

difference in shape

reason for difference [2]

(i) Describe how you could show that the gas collected in this experiment is oxygen.

[1]

2 The salt copper(II) sulphate can be prepared by reacting copper(II) oxide with sulphuric acid.

Complete the list of instructions for making copper(II) sulphate using six of the words below.

blue cool dilute filter saturated sulphate white oxide

Instructions

1 Add excess copper(II) oxide to sulphuric acid in a beaker and boil it.

2 ______________________ to remove the unreacted copper(II) oxide.

3 Heat the solution until it is ______________________

4 ______________________ the solution to form ______________________

coloured crystals of copper (II) [6]
(b) Describe how you could show by adding aqueous sodium hydroxide and aqueous ammonia that a solution contained zinc ions.

result with sodium hydroxide ....................................................................................................................

excess sodium hydroxide ............................................................................................................................

result with aqueous ammonia ...................................................................................................................

excess aqueous ammonia ............................................................................................................................ [3]

(b) A South Korean chemist has discovered a cure for smelly socks. Small particles of silver are attached to a polymer, poly(propene), and this is woven into the socks.

To show that the polymer contains silver the following test was carried out.

_The polymer fibres were chopped into small pieces and warmed with nitric acid. The silver atoms were oxidised to silver(I) ions. The mixture was filtered. Aqueous sodium chloride was added to the filtrate and a white precipitate formed._

(i) Why was the mixture filtered?

......................................................................................................................................................... [1]

(ii) Explain why the change of silver atoms to silver ions is oxidation.

......................................................................................................................................................... [1]

(iii) Give the name of the white precipitate.

......................................................................................................................................................... [1]

(d) Propanoic acid is a weak acid.

(i) The following equation represents its reaction with ammonia.

\[
\text{CH}_3\text{CH}_2\text{COOH} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{COO}^- + \text{NH}_4^+
\]

Explain why propanoic acid behaves as an acid and ammonia as a base.

......................................................................................................................................................... [3]

(ii) Explain the expression weak acid.

......................................................................................................................................................... [1]
(c) Complete the following table by writing “reaction” or “no reaction” in the spaces provided.

<table>
<thead>
<tr>
<th>oxide</th>
<th>type of oxide</th>
<th>reaction with acid</th>
<th>reaction with alkali</th>
</tr>
</thead>
<tbody>
<tr>
<td>magnesium</td>
<td>basic</td>
<td>.....................</td>
<td>.....................</td>
</tr>
<tr>
<td>aluminium</td>
<td>amphoric</td>
<td>.....................</td>
<td>.....................</td>
</tr>
</tbody>
</table>

05w3
5

(c) The major ore of strontium is its carbonate, $\text{SrCO}_3$. Strontium is extracted by the electrolysis of its molten chloride.

(i) Name the reagent that will react with the carbonate to form the chloride.

........................................................................................................................................ [1]

05w3
6

(b) In the above method, a soluble salt was prepared by neutralising an acid with an insoluble base. Other salts have to be made by different methods.

(i) Give a brief description of how the soluble salt, rubidium sulphate could be made from the soluble base, rubidium hydroxide.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................ [3]

(ii) Suggest a method of making the insoluble salt, calcium fluoride.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................ [3]
(c) The equation for the reaction of X with cold water is given below.

\[ 2X(s) + 2H_2O(l) \rightarrow 2XOH(aq) + H_2(g) \]

(i) Describe the test you would use to show that the gas evolved is hydrogen.

.......................................................................................................................................................... [1]

(ii) How could you show that the water contained a compound of the type XOH?

.......................................................................................................................................................... [2]

(iii) In which group of the Periodic Table does metal X belong?

.......................................................................................................................................................... [1]

(iv) The ore of X is its chloride. Suggest how metal X could be extracted from its chloride.

.......................................................................................................................................................... [2]
3 (a) Four bottles were known to contain aqueous ammonia, dilute hydrochloric acid, sodium hydroxide solution and vinegar, which is dilute ethanoic acid. The bottles had lost their labels. The pH values of the four solutions were 1, 4, 10 and 13.

Complete the table.

<table>
<thead>
<tr>
<th>solution</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>aqueous ammonia</td>
<td></td>
</tr>
<tr>
<td>dilute hydrochloric acid</td>
<td></td>
</tr>
<tr>
<td>sodium hydroxide solution</td>
<td></td>
</tr>
<tr>
<td>vinegar</td>
<td></td>
</tr>
</tbody>
</table>

[2]

(b) The following apparatus was set up to investigate the electrical conductivity of dilute acids.

![Apparatus diagram]

Dilute sulphuric acid is a strong acid. If it was replaced by a weak acid, what two differences in the observations would you expect to make?

----------------------------------------------------------------------------------------------------------------------- [2]

(c) When nitric acid is added to water the following reaction occurs.

\[
\text{HNO}_3 + \text{H}_2\text{O} \rightarrow \text{NO}_3^- + \text{H}_2\text{O}^+
\]

Give the name and the formula of the particle which is transferred from nitric acid to water.

name................................................................................................................................. [2]

formula .................................................................................................................................... [2]
(d) This question is concerned with the following oxides.

aluminium oxide \( \text{Al}_2\text{O}_3 \)
calcium oxide \( \text{CaO} \)
carbon dioxide \( \text{CO}_2 \)
carbon monoxide \( \text{CO} \)
magnesium oxide \( \text{MgO} \)
sulphur dioxide \( \text{SO}_2 \)

(i) Which of the above oxides will react with hydrochloric acid but not with aqueous sodium hydroxide?

............................................................................................................................................... [1]

(ii) Which of the above oxides will react with aqueous sodium hydroxide but not with hydrochloric acid?

............................................................................................................................................... [1]

(iii) Which of the above oxides will react both with hydrochloric acid and with aqueous sodium hydroxide?

............................................................................................................................................... [1]

(iv) Which of the above oxides will react neither with hydrochloric acid nor with aqueous sodium hydroxide?

............................................................................................................................................... [1]
3 There are three methods of preparing salts.

Method A – use a burette and an indicator.

Method B – mix two solutions and obtain the salt by precipitation.

Method C – add an excess of base or a metal to a dilute acid and remove the excess by filtration.

For each of the following salt preparations, choose one of the methods A, B or C, name any additional reagent needed and then write or complete the equation.

(i) the soluble salt, zinc sulphate, from the insoluble base, zinc oxide

method .......................................................................................................................... 
reagent .......................................................................................................................... 
word equation ............................................................................................................. [3]

(ii) the soluble salt, potassium chloride, from the soluble base, potassium hydroxide

method .......................................................................................................................... 
reagent ..........................................................................................................................

equation .................................................................................................................... → KCl + H₂O [3]

(iii) the insoluble salt, lead(II) iodide, from the soluble salt, lead(II) nitrate

method .......................................................................................................................... 
reagent ..........................................................................................................................

equation Pb²⁺ + ............................................................................................................ → .......................................................... [4]

[Total: 10]
5 Methylamine, CH₃NH₂, is a weak base. Its properties are similar to those of ammonia.

(a) When methylamine is dissolved in water, the following equilibrium is set up.

\[
\text{CH₃NH₂} + \text{H₂O} \rightleftharpoons \text{CH₃NH₃⁺} + \text{OH}^-
\]

(i) Suggest why the arrows are not the same length. 

.......................................................................................................................................................... [1]

(ii) Explain why water is stated to behave as an acid and methylamine as a base. 

.......................................................................................................................................................... [2]

(b) An aqueous solution of the strong base, sodium hydroxide, is pH 12. Predict the pH of an aqueous solution of methylamine which has the same concentration. Give a reason for your choice of pH.

.......................................................................................................................................................... [2]

(c) Methylamine is a weak base like ammonia.

(i) Methylamine can neutralise acids.

\[
2\text{CH₃NH₂} + \text{H₂SO₄} \rightarrow (\text{CH₃NH₃})₂ \text{SO₄}
\]
methylammonium sulphate

Write the equation for the reaction between methylamine and hydrochloric acid. Name the salt formed.

.......................................................................................................................................................... [2]

(ii) When aqueous methylamine is added to aqueous iron(II) sulphate, a green precipitate is formed. What would you see if iron(III) chloride solution had been used instead of iron(II) sulphate?

.......................................................................................................................................................... [1]

(iii) Suggest the name of a reagent that will displace methylamine from one of its salts, for example methylammonium sulphate.

.......................................................................................................................................................... [1]
Carbonyl chloride, COCl₂, is a colourless gas. It is made by the following reaction.

\[
\text{CO(g)} + \text{Cl}_2(g) \rightleftharpoons \text{COCl}_2(g)
\]

(c) Carbonyl chloride reacts with water to form two acidic compounds. Suggest which acidic compounds are formed.

1. ..............................................................................................................................
2. .............................................................................................................................. [2]

Sulphuric acid is a typical strong acid.

(a) Change the equations given into a different format.

(i) \[ \text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2 \]
Change into a word equation.

.............................................................................................................................. [1]

(ii) \[ \text{lithium oxide} + \text{sulphuric acid} \rightarrow \text{lithium sulphate} + \text{water} \]
Change into a symbol equation.

.............................................................................................................................. [2]

(iii) \[ \text{CuO} + 2\text{H}^+ \rightarrow \text{Cu}^{2+} + \text{H}_2\text{O} \]
Change the ionic equation into a symbol equation.

.............................................................................................................................. [2]

(iv) \[ \text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2 + \text{H}_2\text{O} \]
Change into a word equation.

.............................................................................................................................. [1]

(b) When sulphuric acid dissolves in water, the following reaction occurs.

\[ \text{H}_2\text{SO}_4 + \text{H}_2\text{O} \rightarrow \text{HSO}_4^- + \text{H}_3\text{O}^+ \]

Explain why water is behaving as a base in this reaction.

.............................................................................................................................. [2]

(c) Sulphuric acid is a strong acid, ethanoic acid is a weak acid. Explain the difference between a strong acid and a weak acid.

.............................................................................................................................. [2]
7 Crystals of sodium sulphate-10-water, Na₂SO₄·10H₂O, are prepared by titration.

(a) 25.0 cm³ of aqueous sodium hydroxide is pipetted into a conical flask. A few drops of an indicator are added. Using a burette, dilute sulphuric acid is slowly added until the indicator just changes colour. The volume of acid needed to neutralise the alkali is noted.

Suggest how you would continue the experiment to obtain pure, dry crystals of sodium sulphate-10-water.

............................................................................................................................................................................
............................................................................................................................................................................
............................................................................................................................................................................
............................................................................................................................................................................
............................................................................................................................................................................ [4]
1 Complete the following table.

<table>
<thead>
<tr>
<th>gas</th>
<th>test for gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonia</td>
<td>bleaches damp litmus paper</td>
</tr>
<tr>
<td>hydrogen</td>
<td>relights a glowing splint</td>
</tr>
<tr>
<td></td>
<td>turns limewater milky</td>
</tr>
</tbody>
</table>

[Total: 5]

5 Insoluble salts are made by precipitation.

(a) A preparation of the insoluble salt calcium fluoride is described below.

To 15 cm$^3$ of aqueous calcium chloride, 30 cm$^3$ of aqueous sodium fluoride is added. The concentration of both solutions is 1.00 mol/dm$^3$. The mixture is filtered and the precipitate washed with distilled water. Finally, the precipitate is heated in an oven.

(i) Complete the equation.

$$\text{Ca}^{2+} + \ldots \ldots \text{F}^{-} \rightarrow \ldots \ldots \ldots \ldots$$

[2]

(ii) Why is the volume of sodium fluoride solution double that of the calcium chloride solution?

........................................................................................................................................
........................................................................................................................................ [1]

(iii) Why is the mixture washed with distilled water?

........................................................................................................................................
........................................................................................................................................ [1]

(iv) Why is the solid heated?

........................................................................................................................................
........................................................................................................................................ [1]
(b) The formulae of insoluble compounds can be found by precipitation reactions.

To 12.0 cm$^3$ of an aqueous solution of the nitrate of metal T was added 2.0 cm$^3$ of aqueous sodium phosphate, Na$_3$PO$_4$. The concentration of both solutions was 1.00 mol/dm$^3$. When the precipitate had settled, its height was measured.

The experiment was repeated using different volumes of the phosphate solution. The results are shown on the following graph.

What is the formula of the phosphate of metal T? Give your reasoning.

........................................................................................................................................ [3]
(b) They react with water to form acidic solutions.

\[
\begin{align*}
\text{HCl} & \quad + \quad \text{H}_2\text{O} \quad \Leftrightarrow \quad \text{H}_3\text{O}^+ \quad + \quad \text{Cl}^- \\
\text{HF} & \quad + \quad \text{H}_2\text{O} \quad \Leftrightarrow \quad \text{H}_3\text{O}^+ \quad + \quad \text{F}^-
\end{align*}
\]

(i) Explain why water behaves as a base in both of these reactions.

........................................................................................................................................................ [2]

(ii) At equilibrium, only 1% of the hydrogen chloride exists as molecules, the rest has formed ions. In the other equilibrium, 97% of the hydrogen fluoride exists as molecules, only 3% has formed ions.

What does this tell you about the strength of each acid?

........................................................................................................................................................ [2]

(iii) How would the pH of these two solutions differ?

........................................................................................................................................................ [1]
Oxides are classified as acidic, basic, neutral and amphoteric.

(a) Complete the table.

<table>
<thead>
<tr>
<th>type of oxide</th>
<th>pH of solution of oxide</th>
<th>example</th>
</tr>
</thead>
<tbody>
<tr>
<td>acidic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>basic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>neutral</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) (i) Explain the term *amphoteric*.

....................................................................................................................................................... [1]

(ii) Name two reagents that are needed to show that an oxide is amphoteric.

....................................................................................................................................................... [2]

(b) Beryllium hydroxide, a white solid, is an amphoteric hydroxide.

(i) Name another metal which has an amphoteric hydroxide.

....................................................................................................................................................... [1]

(ii) Suggest what you would observe when an excess of aqueous sodium hydroxide is added gradually to aqueous beryllium sulfate.

....................................................................................................................................................... [2]
8 Soluble salts can be made using a base and an acid.

(a) Complete this method of preparing dry crystals of the soluble salt cobalt(II) chloride·6-water from the insoluble base cobalt(II) carbonate.

Step 1
Add an excess of cobalt(II) carbonate to hot dilute hydrochloric acid.

Step 2

Step 3

Step 4

[4]
Mark Scheme

01w3

4 (a) (i) heat (ignore air) or roast NOT burn [1]

(ii) zinc sulphide or roast or burn or sulphur dioxide formed [1]
zinc oxide [1]
reduce with carbon or dissolve zinc oxide in sulphuric acid and electrolyse [1]
NOT electrolysis of blende or oxide [1]

(b) hydrochloric acid
excess zinc oxide [1]
filter [1]

OR add hydrochloric acid forms (zinc chloride and) water [Max 2]

01w3

5

(d) (i) completely ionized or good proton donor
for explanation based on high concentration of H⁺ or low pH or proton donor ONLY [1]

(ii) word equation correct
water missing ONLY [1]
accept correct symbol equation [2]

(iii) 2NaOH + H₂SO₄ → Na₂SO₄ + 2H₂O
unbalanced [1] NOT word equation
or NaOH + H₂SO₄ → NaH₂SO₄ + H₂O

(iv) Mg + 2H⁺ → Mg²⁺ + H₂
molecular equation ONLY [1] NOT word equation [2]

02s3

2 (a) (i) limestone or quicklime or calcium oxide [1]
or marble or chalk or calcium carbonate
NOT just lime

(ii) Ca²⁺ and SO₄²⁻ [2]

(iii) blue precipitate accept light blue precipitate
then blue solution [1]
dissolves or solution [1]
deep blue [1]
(d) (i) balanced

(ii) pH
phosphorous acid has higher pH

OR electrical conductivity
phosphorous acid poorer

OR reaction with named metal or carbonate
hydrobromic faster

OR pH indicator
correct colours

(e) (i) proton or hydrogen ion

(ii) base or proton acceptor or electron pair donor

02w3
1
(b) sodium hydroxide or carbonate or hydrogen carbonate
zinc oxide or hydroxide or carbonate
NOT zinc

barium nitrate or chloride or hydroxide or barium ions
neutralisation NOT acid/base

02w3
2
(b) (i) manganese chloride
water

(ii) manganese(III) and (IV) oxides

03s3
1
(b) (i) white precipitate
COND upon a precipitate
dissolves in excess or forms solution

(ii) blue precipitate
COND upon a precipitate
does not dissolve in excess
(d) Add excess lead oxide to nitric acid can imply excess filter NOT if residue is lead nitrate evaporate or heat solution

(c) (i) proton hydrogen ion or $H^+$ ONLY [1]
     (ii) correct equation molecular or ionic
     \[ \text{NH}_3 + \text{HCl} = \text{NH}_4\text{Cl} \]
     \[ \text{NH}_3 + \text{H}^+ = \text{NH}_4^+ \text{ accept NH}_4\text{OH} \]
(d) measure pH or add universal indicator or pH meter ammonia has lower pH if numerical values given

must be appropriate that is above 7 with ammonia having the lower value or correct colours, green and blue are acceptable OR measure conductivity ammonia has poorer conductivity

03w3
5 (c)
(ii) barium sulphate cond bromine oxidises or reacts with sulphur dioxide to form sulphate ion

04s3
2 (b)
(iii) $\text{Ca}_3(\text{PO}_4)_2$

\[ \text{Ca}(\text{H}_2\text{PO}_4)_2 \]
(iv) only acceptable responses are: accepts a proton accepts $\text{H}^+$ [1] only
4  (a)  (i)  Named soluble zinc salt
corresponding sodium salt
If hydroxide or oxide then 0/2 [1] [1]
(ii) Correct equation
not balanced [1] only [2]
(iii) Correct equation [2]

(b)  (i)  $\text{Fe}^{3+} + 3\text{OH}^- = \text{Fe(OH)}_3$ [1]
(ii) Max at 8cm$^3$
Same shape of graph [1]

Just the above shape, the height of the precipitate and the volume
of sodium hydroxide are irrelevant [1]

(iii) Maximum then height of precipitate decreases
or graph slopes down to x axis or comes to zero
hydroxide dissolves in excess or it is amphoteric [1]

04w3
1

(d)  (i)  glowing splint burst into flame or rekindled
Must have glowing or equivalent idea
OR any similar description that includes the two points glowing and relights.

04w3
2
dilute
filter
saturated
cool
blue
sulphate [6]

05s3
2

(b) for zinc and sodium hydroxide white precipitate
   dissolves in excess (only if precipitate mentioned) [1] [1]

for zinc and ammonia same results [1]
Mark either first (sodium hydroxide or aqueous ammonia), if completely correct, then an
additional [1] can be awarded for stating that the other has the same results.

05s3
3
(b) (i) to remove fibres or remove solid NOT precipitate, NOT impurities, NOT to obtain a filtrate [1]

(ii) because silver atoms have lost electrons OR oxidation number increased [1]

(iii) silver chloride [1]

(d) (i) acid loses a proton base accepts a proton [2]

OR same explanation but acid loses a hydrogen ion (1) and base gains hydrogen ion (1) [1]

(ii) only partially ionised or poor hydrogen ion donor or poor proton donor NOT does not form many hydrogen ions in water or low concentration of hydrogen ions NOT pH [1]

(c) reaction reaction no reaction no reaction [1]

(c)(i) hydrochloric acid [1]

(b)(i) sulphuric acid
COND description of titration repeat without indicator or with carbon evaporation any TWO [3]


(c)  (i) goes "pop" with burning splint
    or mixed with air and ignited goes pop
    NOT glowing splint

  (ii) test and observable result
       universal indicator goes blue
       or pH paper goes blue
       or high pH, accept 13, 14
       or ammonium ion gives off ammonia
       or with metallic cations forms a precipitate
       NOT litmus
       ONLY accept - neutralises acids with an observable result,
       e.g. becomes warm.

  (iii) Group 1

  (iv) electrolysis
       COND molten

06s3

3  (a) ammonia 10
    hydrochloric acid 1
    sodium hydroxide 13
    ethanoic acid 4
    All correct
    Two correct [1]

(b) With strong acid bulb brighter
    faster rate of bubbles
    OR corresponding comments for weak acid

(c) proton NOT hydrogen ion
    \( H^+ \) not conditional on proton
    Only way for [2] is proton and \( H^+ \)

06s3

(d)  (i) CaO and MgO

  (ii) CO₂ and SO₂

  (iii) Al₂O₃

  (iv) CO

08s31

3  (i) method C
    sulphuric acid (allow if given in equation)
    zinc oxide + sulphuric acid = zinc sulphate + water

(ii) method A
    hydrochloric acid
    \( KOH + HCl = KCl + H₂O \)

(iii) method B
    potassium iodide or any soluble iodide
    \( Pb^{2+} + 2I^- = PbI₂ \) accept a correct equation even if soluble iodide is wrong
    Not balanced - \( Pb^{2+} + I^- = PbI₂ \) ONLY [1]
5 (a) (i) equilibrium to left or many molecules and few ions or partially ionised or reverse reaction favoured

(ii) Water donates proton
methyamine accepts a proton

NOTE if hydrogen ion then ONLY [1] provided both are correct

(b) less than 12 more than 7
smaller concentration of hydroxide ions or partially dissociated or poor proton acceptor or poor H⁺ acceptor

NOT it is a weak base

(c) (i) CH₃NH₂ + HCl = CH₃NH₃Cl
methylammonium chloride

NOTE the equation must be as written, the equation with sulphuric acid has been given as guidance.

(ii) brown precipitate

ACCEPT orange or red/brown or brick red or brown/red

(iii) sodium hydroxide or any named strong base

08s31

5 (c) hydrogen chloride or hydrochloric acid
carbon dioxide or carbonic acid or hydrogen carbonate

08s31

4 (a) (i) magnesium + sulphuric acid = magnesium sulphate + hydrogen

ACCEPT hydrogen sulphate

(ii) Li₂O + H₂SO₄ → Li₂SO₄ + H₂O

formulae correct but not balanced [1]

(iii) CuO + H₂SO₄ → CuSO₄ + H₂O

OR CuO + 2HCl → CuCl₂ + H₂O

OR CuO + 2HNO₃ → Cu(NO₃)₂ +H₂O

formulae correct but not balanced [1]

(iv) sodium carbonate + sulphuric acid → sodium sulphate + carbon dioxide + water

(b) it accepts a proton

it accepts a hydrogen ion [1] ONLY

(c) sulphuric acid is completely ionised

or few molecules and many ions

ethanoic acid is partially ionised

or many molecules and few ions
7 (a) repeat experiment without indicator or use carbon to remove indicator (partially) evaporate or boil or heat allow to cool or crystallise or crystals dry crystals MUST be in correct order NB evaporate to dryness, marks one and two ONLY

08w31

1 red litmus paper blue OR white fumes/smoke with HCl (g) or (aq)
chlorine
“pop” with a lighted splint or burn with a pop or goes pop and extinguishes flame NOT glowing splint
oxygen
carbon dioxide ACCEPT correct formulae

[Total: 5]

09s31

5 (a) (i) \( \text{Ca}^{2+} + 2F^- \rightarrow \text{CaF}_2 \)
Not balanced ONLY [1]
Both species must be correct for first mark. Second mark is for correct balancing.

(ii) Mole ratio \( \text{Ca}^{2+} : F^- \) is 1:2
Answer must mention moles accept argument based on charges or number of ions accept 2 moles of NaF react with 1 mole of CaCl₂ NOT just “2” in equation If fluorine must specify atoms or ions

(iii) to remove traces of solutions or to remove soluble impurities or to remove a named salt sodium chloride or sodium fluoride or calcium chloride To remove impurities is not enough

(iv) to dry (precipitate) or to remove water or to evaporate water NOT to evaporate some of water NOT to crystallise salt

09s31

5

(b) \( T_3(\text{PO}_4)_2 \) allow correct example explain why 8 cm³ react fully comment about mole ratio

709s31
(b) (i) because it accepts a proton
accepts hydrogen ion or H⁺ ONLY [1]
proton and H⁺ [2]

(ii) hydrogen chloride is a strong acid
hydrogen fluoride is a weak acid
weaker or stronger correctly applied for [2]

(iii) hydrogen chloride (aqueous) would have lower pH
OR hydrogen fluoride (aqueous) would have higher pH
If values suggested, not over 7

09w3
2  (a) pH < 7
example [1]

pH > 7
example [1]
NOT amphoteric oxides Be, Al, Zn, Pb, Sn etc [1]

pH = 7
example H₂O, CO, NO
the two marks are not linked, mark each independently
NOT amphoteric oxides Be, Al, Zn, Pb, Sn etc.

(b) (i) shows both basic and acidic properties [1]

(ii) a named strong acid
a named alkali [1]

10w3
6
(b) (i) zinc / aluminium / lead / tin / chromium [1]

(ii) white precipitate
precipitate dissolves / colourless solution forms / forms a clear solution
soluble in excess [1]

10w3
8  (a) filter / centrifuge / decant
(partially) evaporate / heat / boil
allow to crystallise / cool / let crystals form
dry crystals / dry between filter paper / leave in a warm place to dry
“dry” on its own must be a verb
evaporate to dryness only marks 1 and 2
note if discuss residue only mark 1
The diagrams show the apparatus used to find the concentration of a nitric acid solution.

25.0 cm$^3$ of nitric acid was added to a flask.

Sodium hydroxide was added to the acid until the solution was neutral. The volume of the sodium hydroxide was noted.

(a) Complete the boxes to name the apparatus used.

(b) How could you tell when the solution was neutral?

(c) How could the accuracy of the results be checked?
The solid P contained the iron(II) cation, another cation and one anion.  
The tests on an aqueous solution of P and some of the observations are in the following table.  
Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>To about 1cm³ of solution P was added excess aqueous sodium hydroxide and shaken</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>The mixture was heated gently until boiling. The gas given off was tested with pH indicator paper.</td>
</tr>
<tr>
<td></td>
<td>Indicator paper turned blue pH 11</td>
</tr>
<tr>
<td>(b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To about 1 cm³ of solution P, was added a few drops of dilute sulphuric acid and potassium manganate(VII) solution. The colour change was noted. The iron(II) ions were oxidised to iron(III) ions.</td>
</tr>
<tr>
<td></td>
<td>Aqueous sodium hydroxide was added with shaking until no further change.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To 1 cm³ of solution P, was added aqueous ammonia with shaking until excess ammonia was present.</td>
</tr>
<tr>
<td></td>
<td>After 5 minutes, describe the surface of the mixture.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To 1 cm³ of solution P was added drops of dilute hydrochloric acid and then aqueous barium chloride.</td>
</tr>
<tr>
<td></td>
<td>white precipitate</td>
</tr>
<tr>
<td>(e)</td>
<td>What gas is given off in test (a)?</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(f)</td>
<td>Identify the other cation present in solid P.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(g)</td>
<td>Identify the anion present in solid P.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The apparatus below was used to make carbon dioxide. Dilute hydrochloric acid was added to calcium carbonate.

(a) Identify the pieces of apparatus labelled:

A .................................................................

B .................................................................

C ................................................................. [3]

(b) Indicate on the diagram with an arrow where the acid was added. [1]

(c) State a test for carbon dioxide.

test ..................................................................................

result ............................................................................. [2]
2 The label shows the substances present in a bottle of lemon drink.

(a) A piece of litmus paper was dipped in the drink.

(i) What colour will the paper turn?

....................................................................................................................[1]

(ii) Why does using litmus paper give a better result than adding Universal Indicator solution to the drink?

....................................................................................................................[1]
Two solid compounds S and T were tested. The tests on S and T and some of the observations are in the following table. S was copper(II) oxide. Complete the observations in the table.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Observations</th>
</tr>
</thead>
</table>
| (a) Appearance of S and T. | S black solid  
T black solid |
| (b) (i) Solid S was added to aqueous hydrogen peroxide.  
The mixture was boiled. The gas given off was tested with a glowing splint. | no reaction  
splint extinguished |
| (ii) Solid T was added to aqueous hydrogen peroxide.  
The gas given off was tested with a glowing splint. | rapid effervescence  
splint relit |
| (c) (i) Solid T was added to hydrochloric acid and heated.  
The gas given off was tested with damp blue litmus paper. | litmus paper bleached |
| (ii) Test (c)(i) was repeated using solid S.  
The colour of the solution was noted. | green solution |
| (d) The solution from (c)(ii) was divided into two equal portions of 1 cm³. |  
(i) To the first portion was added excess aqueous sodium hydroxide.  
[2]  
(ii) To the second portion was added excess aqueous ammonia. [3] |
(e) Name the gas given off in test (b)(ii). .................................................................[1]

(f) Name the gas given off in test (c)(i). ....................................................................[1]

(g) What conclusions can you draw about solid T? ....................................................
.................................................................................................................................................[2]

3 The apparatus below was used to investigate the speed of the reaction between an excess of dilute sulphuric acid and 4 cm of magnesium ribbon.

(a) (i) What is the purpose of the test-tube? .................................................................[1]

(ii) What is the purpose of the gas syringe? .................................................................[1]

(b) How was the reaction started? ................................................................................[1]
7 Describe a chemical test to distinguish between each of the following pairs of substances. An example is given.

potassium chloride and potassium iodide

**test:** add aqueous lead(II) nitrate

**result:** potassium chloride gives a white precipitate, potassium iodide gives a yellow precipitate

(a) hydrochloric acid and aqueous sodium chloride

**test** ..........................................................[2]

**result** ..........................................................

.............................................................................[2]

(c) sulphuric acid and nitric acid

**test** ..........................................................

**result** ..........................................................

.............................................................................[2]
A student investigated the neutralisation of dilute hydrochloric acid, using an excess of calcium carbonate.

Step 1. Excess calcium carbonate was added to hydrochloric acid.

Step 2. Excess calcium carbonate was removed from the solution.

Step 3. The solution of calcium chloride was tested with indicator paper.

(a) Identify the pieces of apparatus labelled:

A..........................................................................................................................................

B..........................................................................................................................................

C...........................................................................................................................................[3]

(b) What does the term excess mean?

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

...........................................................................................................................................[1]

(c) Suggest the pH value of the solution of calcium chloride.

...........................................................................................................................................[1]
5 Two liquids, F and G, were tested. The tests and some of the observations are in the following table. G was an aqueous solution of a metal iodide.

Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) (i) Appearance of liquid F.</td>
<td>colourless</td>
</tr>
<tr>
<td></td>
<td>smells like petrol</td>
</tr>
<tr>
<td>(ii) Appearance of liquid G.</td>
<td>colourless</td>
</tr>
<tr>
<td></td>
<td>no smell</td>
</tr>
<tr>
<td>(b) (i) About 1 cm$^3$ of liquid F was</td>
<td>purple solution</td>
</tr>
<tr>
<td>added to a crystal of iodine.</td>
<td></td>
</tr>
<tr>
<td>The test-tube was shaken.</td>
<td></td>
</tr>
<tr>
<td>(ii) About 1 cm$^3$ of liquid G was added</td>
<td>red/brown solution</td>
</tr>
<tr>
<td>to a crystal of iodine. The test-tube was</td>
<td></td>
</tr>
<tr>
<td>shaken.</td>
<td></td>
</tr>
<tr>
<td>The mixture from (b)(i) was added to the</td>
<td>two layers formed</td>
</tr>
<tr>
<td>mixture in (b)(ii).</td>
<td></td>
</tr>
<tr>
<td>(c) A few drops of F were placed on a</td>
<td></td>
</tr>
<tr>
<td>dry watch glass.</td>
<td></td>
</tr>
<tr>
<td>The liquid was touched with a lighted splint.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2]</td>
</tr>
<tr>
<td>(d) To about 1 cm$^3$ of liquid G was</td>
<td></td>
</tr>
<tr>
<td>added a few drops of dilute nitric acid</td>
<td></td>
</tr>
<tr>
<td>followed by aqueous lead(II) nitrate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2]</td>
</tr>
<tr>
<td>(e) To about 1 cm$^3$ of liquid G was</td>
<td></td>
</tr>
<tr>
<td>added a few drops of dilute nitric acid</td>
<td></td>
</tr>
<tr>
<td>followed by aqueous silver nitrate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2]</td>
</tr>
</tbody>
</table>

(f) What type of substance is liquid F?

.................................................................................................................................
................................................................................................................................. [2]
6 The following paragraph was taken from a student's notebook.

To make potassium chloride

25.0 cm$^3$ of aqueous potassium hydroxide were placed in a flask and a few drops of indicator were added. Dilute hydrochloric acid was added to the flask until the indicator changed colour. The volume of acid used was 19.0 cm$^3$.

(a) What piece of apparatus should be used to measure the aqueous potassium hydroxide?

...........................................................................................................................................[1]

(b) (i) Name a suitable indicator that could be used.

...........................................................................................................................................[1]

(ii) The indicator colour would change

from.........................................................

to.........................................................[2]

(c) Which solution was more concentrated? Explain your answer.

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

...........................................................................................................................................[2]

(d) How could pure crystals of potassium chloride be obtained from this experiment?

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

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

...........................................................................................................................................[3]
2. Hydrogen chloride gas is strong-smelling, denser than air and soluble in water. A sample of hydrogen chloride gas can be prepared by adding concentrated sulphuric acid to sodium chloride. Study the diagram of the apparatus used.

(a) Fill in the boxes to show the chemicals used.  

(b) Identify and explain two mistakes in the diagram.

Mistake 1: .................................................................................................................................................. [2]

Mistake 2: .................................................................................................................................................. [2]

(c) State one precaution that should be taken when carrying out this experiment.

.............................................................................................................................................................. [1]
4 A mixture of two solid compounds D and E was analysed. Solid D was a zinc salt which is soluble in water. Solid E was an insoluble metal carbonate. The tests on the mixture and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) About half of the mixture of D and E was placed in a test-tube. The mixture was heated</td>
<td>green to black condensation formed</td>
</tr>
<tr>
<td>(b) The rest of the mixture of D and E was added to distilled water in a boiling tube. The contents of the tube were filtered. The filtrate and the residue were kept for the following tests.</td>
<td></td>
</tr>
</tbody>
</table>

**test on residue**

<table>
<thead>
<tr>
<th>test on residue</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(c) The residue was transferred from the filter paper into a test-tube. About 3 cm(^3) of dilute sulphuric acid was added. The gas was tested with limewater.</td>
<td>...........................................................................................................</td>
</tr>
<tr>
<td></td>
<td>...........................................................................................................</td>
</tr>
<tr>
<td></td>
<td>...........................................................................................................</td>
</tr>
<tr>
<td></td>
<td>...........................................................................................................[2]</td>
</tr>
</tbody>
</table>

The solution obtained in (c) was divided into two equal portions.

<p>| (d) (i) To the first portion was added excess aqueous sodium hydroxide, a little at a time. | pale blue precipitate |
| (ii) To the second portion was added excess aqueous ammonia, a little at a time.             | ................................................................. |
|                                                                                           | ................................................................. |
|                                                                                           | .................................................................[4] |</p>
<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>test on filtrate</strong></td>
</tr>
<tr>
<td>(e)</td>
<td>The filtrate from (b) was divided into three approximately equal portions.</td>
</tr>
<tr>
<td>(i)</td>
<td>To the first portion were added drops of aqueous sodium hydroxide, a little at a time with shaking.</td>
</tr>
<tr>
<td></td>
<td>Excess aqueous sodium hydroxide was added.</td>
</tr>
<tr>
<td>(ii)</td>
<td>To the second portion was added excess aqueous ammonia a little at a time.</td>
</tr>
<tr>
<td>(iii)</td>
<td>To the third portion were added drops of dilute hydrochloric acid and aqueous barium chloride.</td>
</tr>
<tr>
<td>(f)</td>
<td>What conclusions can you draw about the identity of solid D?</td>
</tr>
<tr>
<td>(g)</td>
<td>What conclusions can you draw about the identity of the cation in solid E?</td>
</tr>
</tbody>
</table>
6 Beach sand is a mixture of sand and broken shells (calcium carbonate). Calcium carbonate reacts with dilute hydrochloric acid to form a solution of calcium chloride.

Plan an investigation to find out the percentage of shell material in a given sample of beach sand.

...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
............................................................................................................................................[6]
4 An aqueous solution of substance $X$ was analysed. Substance $X$ was an iron(III) salt containing one other cation. The tests on $X$ and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Colour of solution $X$</td>
<td>dark yellow</td>
</tr>
<tr>
<td>(b) (i) Drops of aqueous sodium hydroxide were added to about 2 cm$^3$ of the solution. Excess aqueous sodium hydroxide was added to the test-tube.</td>
<td>............................................................</td>
</tr>
<tr>
<td>(i) The mixture was heated. The gas given off was tested with damp indicator paper.</td>
<td>............................................................[3] pungent smell indicator turned blue, pH 10</td>
</tr>
<tr>
<td>(c) Experiment (b)(i) was repeated using aqueous ammonia instead of aqueous sodium hydroxide.</td>
<td>............................................................</td>
</tr>
<tr>
<td>(d) To about 2 cm$^3$ of solution $X$ was added dilute sulphuric acid. Two pieces of zinc were added. The mixture was heated and the gas given off tested.</td>
<td>lighted splint popped</td>
</tr>
<tr>
<td>After 10 minutes the mixture was filtered and test (b)(i) was repeated.</td>
<td>green precipitate insoluble in excess</td>
</tr>
<tr>
<td>(e) A few drops of hydrochloric acid were added to about 2 cm$^3$ of solution $X$. About 1 cm$^3$ of barium chloride solution was added to the mixture.</td>
<td>white precipitate</td>
</tr>
</tbody>
</table>
(f) (i) Name the gas given off in (d).

(ii) What type of chemical reaction occurs in (d). Explain your answer.

(g) What conclusions can you draw about the anion and the other cation in substance X?

anion .................................................................[3]

cation .................................................................[2]
Ammonia is produced when aqueous sodium hydroxide is warmed with ammonium sulphate. Ammonia is less dense than air and very soluble in water. The apparatus below was used to prepare a sample of dry ammonia gas.

![Diagram of apparatus](image)

(a) Name substance C. .................................................................[1]

(b) Name substance D. .................................................................[1]

(c) What necessary piece of equipment is missing in the diagram?

........................................................................................................[1]

(d) Suggest why concentrated sulphuric acid should not be used to dry ammonia.

........................................................................................................[1]

(e) There are two other mistakes in the apparatus shown in the diagram. Identify and explain these mistakes.

mistake 1 ..............................................................................

explanation ..........................................................................

mistake 2 ..............................................................................

explanation ...........................................................................[4]
A mixture of two calcium compounds C and D was tested.

C is partially soluble in water and D is soluble in water.

Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>The mixture of C and D was added to distilled water in a boiling tube. The tube was shaken. The mixture was filtered.</td>
<td></td>
</tr>
<tr>
<td>(a) The filtrate was divided into five equal portions.</td>
<td></td>
</tr>
<tr>
<td>(i) To the first portion was added drops of aqueous sodium hydroxide, a little at a time, with shaking.</td>
<td>................................................................. [2]</td>
</tr>
<tr>
<td>Excess aqueous sodium hydroxide was added.</td>
<td>................................................................. [1]</td>
</tr>
<tr>
<td>(ii) To the second portion was added excess aqueous ammonia, a little at a time.</td>
<td>................................................................. [1]</td>
</tr>
<tr>
<td>(iii) To the third portion was added dilute sodium hydroxide and aluminium powder. The mixture was boiled and the gas tested with damp litmus paper.</td>
<td>red litmus went blue</td>
</tr>
<tr>
<td>(iv) The pH of the fourth portion was tested with Indicator paper.</td>
<td>pH about 10</td>
</tr>
<tr>
<td>(v) Carbon dioxide was bubbled through the fifth portion.</td>
<td>solution turned milky/cloudy</td>
</tr>
</tbody>
</table>

(b) Name the gas given off in (a)(iii). ................................................................. [1]

(c) Suggest an explanation for the observation in (a)(v). ................................................................. [1]
(d) What conclusions can you draw about the identity of the anions in solid C and D?
4 A student investigated the temperature changes that occur when two compounds A and B, react with hydrochloric acid. The apparatus below was used.

![Diagram of experiment setup]

Experiment 1

By using a measuring cylinder, 30 cm$^3$ of hydrochloric acid was added to the plastic cup.

Use the thermometer diagram to record the initial temperature of the acid in the table. The timer was started, and some of the solid A was added to the cup. Immediate effervescence occurred. The mixture was stirred by moving the cup until the fizzing stopped.

More of A was then added and the student continued adding A in this way until all of solid A had been added.

Use the thermometer diagrams to record the temperature of the mixture every half minute.

Experiment 2

Experiment 1 was repeated using solid B. Use the thermometer diagrams to record the temperatures in the table.
### Table of results

#### Experiment 1

<table>
<thead>
<tr>
<th>time/min</th>
<th>0.0</th>
<th>0.5</th>
<th>1.0</th>
<th>1.5</th>
<th>2.0</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>thermometer diagram</td>
<td>25</td>
<td>30</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>temperature/°C</td>
<td>3.0</td>
<td>3.5</td>
<td>4.0</td>
<td>4.5</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>35</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>30</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>25</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

#### Experiment 2

<table>
<thead>
<tr>
<th>time/min</th>
<th>0.0</th>
<th>0.5</th>
<th>1.0</th>
<th>1.5</th>
<th>2.0</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>thermometer diagram</td>
<td>25</td>
<td>25</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>temperature/°C</td>
<td>3.0</td>
<td>3.5</td>
<td>4.0</td>
<td>4.5</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
(a) Plot the results from both experiments on the grid below. For each set of results draw a smooth line graph. Indicate clearly which line represents Experiment 1 and which line Experiment 2.
(b) From your graphs:

(i) Find the temperature of the reaction mixture after the hydrochloric acid had reacted for 2 minutes 15 seconds with

solid A. ................................................................. [2]

solid B. ................................................................. [2]

(ii) What type of chemical reaction occurs when

solid A. .................................................................

solid B .................................................................

reacts with hydrochloric acid? [2]

(c) Suggest what type of compound solids A and B are. Explain your answer

................................................................................................................................. [2]

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

................................................................................................................................. [2]

(d) If the plastic cup and final reaction mixture are left for one hour, predict the temperature at this time for

(i) solid A and hydrochloric acid. .................................................................

(ii) solid B and hydrochloric acid. .................................................................

Explain your answers.

................................................................................................................................. [3]
7 Describe a chemical test to **distinguish** between each of the following pairs of substances. An example is given.

**Potassium chloride and potassium iodide**

**Test:** add aqueous lead(II) nitrate

**Result:** potassium chloride gives a white precipitate, potassium iodide gives a yellow precipitate

(a) **Water and ethanol**

**Test:** .................................................................

**Result with water:** .................................................................

**Result with ethanol:** ................................................................. [2]

(b) **Sulphuric acid and aqueous sodium sulphate**

**Test:** .................................................................

**Result with sulphuric acid:** .................................................................

**Result with aqueous sodium sulphate:** ................................................................. [2]

(c) **Hydrochloric acid and nitric acid**

**Test:** .................................................................

**Result with hydrochloric acid:** .................................................................

**Result with nitric acid:** ................................................................. [2]
1 The apparatus below was used to make hydrogen. Dilute hydrochloric acid was added to zinc.

(a) Identify the pieces of apparatus labelled

A, ........................................................................................................................................

B. ........................................................................................................................................ [2]

(b) Complete the boxes ........................................................................................................ [1]

(c) Give a test for hydrogen.

test ........................................................................................................................................

result ....................................................................................................................................... [2]
5 Salt E, which is ammonium chloride was tested. 

Record all observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Describe the appearance of E</td>
<td>.................................. [2]</td>
</tr>
<tr>
<td>(b) Using a spatula salt E was placed in a hard glass test-tube.</td>
<td>red litmus went blue then blue litmus went red</td>
</tr>
<tr>
<td>Inside the top of the tube was suspended a piece of damp blue litmus paper next to a piece of damp red litmus paper. E was heated gently until gas came out of the tube.</td>
<td></td>
</tr>
<tr>
<td>(c) E was dissolved in water to make an aqueous solution.</td>
<td></td>
</tr>
<tr>
<td>The solution was divided into three test-tubes</td>
<td></td>
</tr>
<tr>
<td>(i) To the first portion, was added a few drops of dilute nitric acid and about 1 cm³ of aqueous silver nitrate.</td>
<td>.................................. [2]</td>
</tr>
<tr>
<td>(ii) To the second portion of solution E, was added about 1 cm³ of lead nitrate solution.</td>
<td>.................................. [2]</td>
</tr>
<tr>
<td>(iii) To the third portion of solution E, was added about 1 cm³ of aqueous sodium hydroxide. The mixture was boiled gently and the gas given off was tested with indicator paper</td>
<td>.................................. [2]</td>
</tr>
<tr>
<td>(d) Name the gas given off in test (c)(iii).</td>
<td>.................................. [1]</td>
</tr>
<tr>
<td>(e) Explain the observations in test (b).</td>
<td>.................................. [2]</td>
</tr>
</tbody>
</table>
6. Describe a chemical test to distinguish between each of the following pairs of substances. An example is given.

   oxygen and carbon dioxide
   test: glowing splint
   result: re-lights in oxygen, no effect with carbon dioxide

(a) aqueous chlorine and aqueous sodium chloride
   test
   result with chlorine
   result with sodium chloride [2]

(b) aqueous iron(II) chloride and aqueous iron(III) chloride
   test
   result with iron(II) chloride
   result with iron(III) chloride [2]

(c) copper sulphate and copper carbonate
   test
   result with copper sulphate
   result with copper carbonate [2]
4 A student investigated an aqueous solution of calcium hydroxide and water.

Two experiments were carried out.

**Experiment 1**

By using a measuring cylinder 25 cm$^3$ of the aqueous solution of calcium hydroxide was placed in a flask. Phenolphthalein indicator was added to the flask. A burette was filled to the 0.0 cm$^3$ mark with solution M of hydrochloric acid.

Solution M was added slowly to the flask until the colour just disappeared. Use the burette diagram to record the volume in the table and complete the column.

![Burette Diagram](image)

**Experiment 2**

Experiment 1 was repeated using a different solution, N, of hydrochloric acid.

Use the burette diagrams to record the volumes in the table and complete the table.

![Initial Burette Diagram](image)

![Initial Burette Diagram](image)

**Initial**

14

15

16

**Final**

35

36

37
Table of results

<table>
<thead>
<tr>
<th>burette readings/cm³</th>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>final reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>initial reading</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>difference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) What type of chemical reaction occurs when hydrochloric acid reacts with calcium hydroxide?

__________________________________________________________________________________________ [1]

(b) (i) In which experiment was the greater volume of hydrochloric acid used?

__________________________________________________________________________________________ [1]

(ii) Compare the volumes of acid used in Experiments 1 and 2.

__________________________________________________________________________________________ [2]

(iii) Suggest an explanation for the difference in volumes.

__________________________________________________________________________________________ [2]

(c) Predict the volume of hydrochloric acid M that would be needed to react completely if Experiment 1 was repeated with 50 cm³ of calcium hydroxide solution.

volume of solution  …………………………………………………………………………………………………………

explanation  …………………………………………………………………………………………………………………… [3]

(d) Suggest one change you could make to the apparatus used in the experiments to obtain more accurate results.

__________________________________________________________________________________________ [1]
5 A sample of a solution of acid A was analysed.

The tests on A, and some of the observations are in the following table.

Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) The pH of the solution was tested using indicator paper</td>
<td>colour</td>
</tr>
<tr>
<td></td>
<td>orange</td>
</tr>
<tr>
<td></td>
<td>pH</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>(b) The solution was divided into three test-tubes</td>
<td></td>
</tr>
<tr>
<td>(i) To the first portion was added a piece of magnesium ribbon. The</td>
<td></td>
</tr>
<tr>
<td>gas was tested with a lighted splint.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2]</td>
</tr>
<tr>
<td>(ii) To the second portion of A was added sodium carbonate. The gas</td>
<td></td>
</tr>
<tr>
<td>was tested with limewater.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2]</td>
</tr>
<tr>
<td>(iii) To the third portion of liquid A was added a spatula measure of</td>
<td></td>
</tr>
<tr>
<td>solid B. The mixture was boiled gently. By using a teat</td>
<td></td>
</tr>
<tr>
<td>pipette the solution was transferred to another test tube.</td>
<td></td>
</tr>
<tr>
<td>Excess aqueous ammonia was added.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>green solution formed</td>
</tr>
<tr>
<td></td>
<td>dark blue solution formed</td>
</tr>
</tbody>
</table>

(c) What does test (a) tell you about the type of acid in solution A?

........................................................................................................................................... [1]

(d) (i) Name the gas given off in test (b)(i).

........................................................................................................................................... [1]

(ii) Name the gas given off in test (b)(ii).

........................................................................................................................................... [1]

(e) Explain the observations in test (b)(iii).

........................................................................................................................................... [2]
7 Samples of concrete were placed in solutions of different pH. The graph shows the percentage corrosion of the samples.

(a) Draw a smooth line graph on the grid

(b) Which point on the grid appears to be inaccurate? Explain your reason for identifying this point.

(c) What happens to the percentage corrosion as the pH changes from 1 to 7?
4 A student investigated an aqueous solution of calcium hydroxide and water.

Two experiments were carried out.

**Experiment 1**

By using a measuring cylinder 25 cm$^3$ of the aqueous solution of calcium hydroxide was placed in a flask. Phenolphthalein indicator was added to the flask. A burette was filled to the 0.0 cm$^3$ mark with solution M of hydrochloric acid.

Solution M was added slowly to the flask until the colour just disappeared. Use the burette diagram to record the volume in the table and complete the column.

![Burette Diagram](image)

**Experiment 2**

Experiment 1 was repeated using a different solution, N, of hydrochloric acid.

Use the burette diagrams to record the volumes in the table and complete the table.

![Burette Diagrams](image)
Table of results

<table>
<thead>
<tr>
<th>burette readings/cm³</th>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>final reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>initial reading</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>difference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) (i) In which experiment was the greater volume of hydrochloric acid used? [1]

(ii) Compare the volumes of acid used in Experiments 1 and 2. [2]
6 The label below is from a bottle of concentrated lemon drink.

<table>
<thead>
<tr>
<th>Concentrated lemon drink</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingredients: Water, sugar, citric acid, preservatives, potassium sorbate (artificial sweetener). Yellow colourings E102 and E104.</td>
</tr>
</tbody>
</table>

(a) What is meant by the term *concentrated*? [1]

(b) Predict the pH of the lemon drink. [1]

(c) Describe an experiment to show that two different yellow colourings are present in the drink. [4]
3 In a set of experiments zinc was reacted with sulphuric acid to form hydrogen. The apparatus below was used.

The same mass of zinc was used each time. The volume of acid used was different each time. Use the syringe diagrams to record the volume of hydrogen produced each time in the table.

<table>
<thead>
<tr>
<th>volume of sulphuric acid/cm³</th>
<th>syringe diagram</th>
<th>volume of hydrogen/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td><img src="image1" alt="Syringe Diagram" /></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><img src="image2" alt="Syringe Diagram" /></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td><img src="image3" alt="Syringe Diagram" /></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td><img src="image4" alt="Syringe Diagram" /></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td><img src="image5" alt="Syringe Diagram" /></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td><img src="image6" alt="Syringe Diagram" /></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td><img src="image7" alt="Syringe Diagram" /></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td><img src="image8" alt="Syringe Diagram" /></td>
<td></td>
</tr>
</tbody>
</table>
(a) Plot the results on the grid below. Draw a smooth line graph.

(b) Use the graph to find the volume of sulphuric acid that will produce 33 cm$^3$ of gas.

(c) What volume of gas is produced if 10 cm$^3$ of sulphuric acid is used?
1. A student reacted sulphuric acid with copper(II) oxide. The diagram shows the procedure followed.

Copper oxide was added until all the sulphuric acid had reacted

50 cm$^3$ of dilute sulphuric acid was measured into a beaker

(a) Complete the boxes to identify the pieces of apparatus labelled. [3]

(b) What is the colour of the solution formed?

...................................................................................................................................................... [1]

(c) Describe how crystals could be quickly obtained from the solution.

...................................................................................................................................................... [2]
5 A solid compound \( X \) was analysed. Solid \( X \) was an aluminium salt. The tests on \( X \) and some of the observations are in the following table.

Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
</table>
| **(a)** One spatula measure of \( X \) was placed into a hard-glass test-tube. The solid was heated gently then strongly. The gas was tested with pH indicator paper. | condensation at top of tube  
paper went red |
| Distilled water was added to \( X \) and shaken to dissolve. The solution was divided into five portions in test-tubes. | |
| **(b) (i)** To the first portion, drops of aqueous sodium hydroxide were added. Excess aqueous sodium hydroxide was then added. | |
| **(ii)** To the second portion, drops of aqueous ammonia were added. Excess ammonia was then added. | |
| **(iii)** To the third portion of solution, hydrochloric acid and barium chloride solution were added. | no visible change |
| **(iv)** To the fourth portion of solution, nitric acid and lead nitrate solution were added. | no visible change |
| **(v)** To the fifth portion, aqueous sodium hydroxide and a spatula measure of aluminium granules were added. The mixture was warmed and the gas tested with indicator paper. | pungent gas  
paper went blue, pH 10 |
(c) What does test (a) tell you about the gas given off?

................................................................................................................................. [1]

(d) What conclusions can you draw about $X$ from tests (b)(iii) and (iv)?

(b)(iii) .................................................................................................................................

(b)(iv) ................................................................................................................................. [2]

(e) Identify the gas in (b)(v).

................................................................................................................................. [1]

(f) What conclusions can you draw about substance $X$?

................................................................................................................................. [2]

05w6

7 Some plants do not grow well in acidic soil. A farmer gives you a small sample of soil from a corner of one of his fields.

(a) Plan an investigation to find out the pH of the soil sample.

You are provided with Universal Indicator solution and common laboratory apparatus.

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

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

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

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

................................................................................................................................. [5]

(b) Why would further experiments be necessary to inform the farmer which plants should be grown in each of his fields?

................................................................................................................................. [2]
A mixture of two compounds, B and C, was tested. Compound B was a water-soluble zinc salt and compound C was insoluble. The tests and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>One measure of the mixture was heated gently then strongly. condensation at the top of the tube</td>
</tr>
<tr>
<td></td>
<td>The gas released was tested with cobalt chloride paper. paper turned pink</td>
</tr>
<tr>
<td></td>
<td>The rest of the mixture was added to about 25 cm³ of distilled water in a boiling tube. The contents of the tube were shaken and filtered. The following tests were carried out.</td>
</tr>
</tbody>
</table>

**Tests on the filtrate**
The solution was divided into 2 cm³ portions in four test-tubes.

<table>
<thead>
<tr>
<th>(b) (i)</th>
<th>Drops of aqueous sodium hydroxide were added to the first portion of the solution.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excess aqueous sodium hydroxide was added.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[3]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(iii)</th>
<th>Using the second portion test (b)(i) was repeated using aqueous ammonia instead of aqueous sodium hydroxide.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[3]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(iii)</th>
<th>To the third portion of solution was added hydrochloric acid and barium nitrate solution. white precipitate</th>
</tr>
</thead>
<tbody>
<tr>
<td>tests</td>
<td>observations</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>(iv) To the fourth portion of solution was added nitric acid and silver nitrate solution.</td>
<td>no visible reaction</td>
</tr>
<tr>
<td><strong>Tests on the residue</strong></td>
<td></td>
</tr>
<tr>
<td>(c) Some of the residue was placed into a test-tube. Dilute hydrochloric acid was added and the gas given off was tested with limewater.</td>
<td>rapid effervescence, limewater turned milky</td>
</tr>
</tbody>
</table>

(d) What does test (a) indicate? ........................................... [1]

(e) What conclusions can you draw about compound B? ......................... [2]

(f) What does test (c) indicate? ........................................... [2]
6  The diagram shows two bottles of liquid oven cleaner.

The oven cleaners contain sodium hydroxide solution. Plan an investigation to show which oven cleaner contains the highest concentration of sodium hydroxide.

[6]
1. The diagram shows the formation of a solution of magnesium hydroxide from magnesium.

(a) Complete the empty boxes to name the pieces of apparatus. [3]

(b) What type of chemical reaction is the burning of magnesium? [1]

(c) Suggest a pH for the solution of magnesium hydroxide. [1]
Two solids, F and G, were analysed. Solid F was an ammonium salt and solid G was a potassium salt.

The tests on F and G and some of the observations are in the following table.

Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid F was added to distilled water and shaken to dissolve. The solution was divided into 4 equal portions in test-tubes.</td>
<td></td>
</tr>
<tr>
<td>(a) (i) The pH of the first portion of the solution was tested using Universal Indicator solution.</td>
<td>colour orange</td>
</tr>
<tr>
<td>(ii) Aqueous sodium hydroxide was added to the second portion and heated gently. The gas given off was tested with damp litmus paper.</td>
<td>pH 5</td>
</tr>
<tr>
<td>(iii) To the third portion of solution, was added dilute nitric acid and then aqueous lead(II) nitrate.</td>
<td></td>
</tr>
<tr>
<td>(iv) To the fourth portion of solution, was added dilute nitric acid followed by aqueous silver nitrate.</td>
<td></td>
</tr>
<tr>
<td>(b) (i) Solid G was dissolved in distilled water. The solution was divided into two test-tubes.</td>
<td></td>
</tr>
<tr>
<td>(ii) (a)(iii) was repeated using the first portion of the solution.</td>
<td>bright yellow precipitate</td>
</tr>
<tr>
<td>(iii) (a)(iv) was repeated using the second portion of the solution.</td>
<td>pale yellow precipitate</td>
</tr>
</tbody>
</table>
(c) What conclusion can be drawn from test (a)(i)?

......................................................................................................................... [2]

(d) Name the gas given off in (a)(ii).

......................................................................................................................... [1]

(e) Identify solid F.

......................................................................................................................... [1]

(f) Identify solid G.

......................................................................................................................... [1]
A sample of solid C was analysed. C is a mixture of two salts, D and E. Solid D is insoluble lead carbonate and solid E is water-soluble. The tests on C, and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Describe the appearance of C.</td>
<td>pale green solid</td>
</tr>
<tr>
<td>(b) Using a spatula, place a little of C</td>
<td>paper turns blue</td>
</tr>
<tr>
<td>in a hard glass test-tube. Inside the</td>
<td>pH 8 to 11</td>
</tr>
<tr>
<td>top of the tube suspend a</td>
<td></td>
</tr>
<tr>
<td>piece of damp indicator paper. Heat</td>
<td></td>
</tr>
<tr>
<td>C gently until gas comes out of the</td>
<td></td>
</tr>
<tr>
<td>tube.</td>
<td></td>
</tr>
<tr>
<td>(c) Using a spatula, place a little of C</td>
<td></td>
</tr>
<tr>
<td>in a test-tube. Add about 2 cm³ of</td>
<td></td>
</tr>
<tr>
<td>dilute nitric acid and test the gas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[3]</td>
</tr>
</tbody>
</table>

Solid C was added to a boiling tube containing distilled water. The tube was shaken to mix the contents. The contents of the boiling tube were filtered.

<table>
<thead>
<tr>
<th>tests on the residue in the filter paper</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(d) Place the funnel in a test-tube.</td>
<td></td>
</tr>
<tr>
<td>Pour dilute nitric acid onto the</td>
<td></td>
</tr>
<tr>
<td>residue contained in the funnel. Add</td>
<td></td>
</tr>
<tr>
<td>2 cm³ of potassium iodide to the</td>
<td></td>
</tr>
<tr>
<td>solution collected in the tube.</td>
<td>[2]</td>
</tr>
<tr>
<td>tests on the filtrate</td>
<td>observations</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td><strong>(e)</strong> Divide the filtrate into three test-tubes.</td>
<td></td>
</tr>
<tr>
<td><strong>(i)</strong> To the first portion add dilute hydrochloric acid and about 1 cm$^3$ of aqueous barium nitrate.</td>
<td>white precipitate</td>
</tr>
<tr>
<td><strong>(ii)</strong> To the second portion of solution add excess aqueous ammonia.</td>
<td>green precipitate</td>
</tr>
<tr>
<td><strong>(iii)</strong> To the third portion of solution, add an equal volume of aqueous sodium hydroxide. [\text{Warm the mixture gently. Test the gas with indicator paper.}]</td>
<td>green precipitate [\text{paper turned blue}] [\text{pH 8 to 11}]</td>
</tr>
</tbody>
</table>

**f)** Name the gas given off in (c).

........................................................................................................... [1]

**g)** Name the gas given off in (e)(iii).

........................................................................................................... [1]

**h)** What conclusions can you draw about salt E?

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

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

........................................................................................................... [4]

[Total: 11]
7 When cement powder is added to water a reaction takes place.

(b) How could you show that the solution contains calcium ions?

[2]

[Total: 6]
3 The information in the box is about the preparation of zinc nitrate crystals.

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

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

................................................................................................................................................ [1]

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

................................................................................................................................................ [1]

(c) (i) What is meant by the term saturated solution?

................................................................................................................................................ [2]

(ii) What practical method could show the solution to be saturated?

................................................................................................................................................ [1]

(d) Why are the crystals dried in Step 7 using filter paper instead of by heating?

................................................................................................................................................ [1]
Three different liquids P, Q and R were analysed. Q was an aqueous solution of sodium hydroxide. The tests on the liquids and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
</table>
| (a) Test the pH of the liquids using indicator paper. Note the colour of the paper. | P colour red  
phH 1  
Q colour ..................................................  
phH .................................................. [2]  
R colour orange  
phH 5 |
| (b)  
(i) Add a 5cm piece of magnesium to about 3 cm³ of liquid P in a test-tube. Test the gas given off. | bubbles of gas  
lighted splint pops |
| (ii) Repeat (b)(i) using liquids Q, and R. Do not test for any gases. | Q ..................................................  
R .................................................. [2] |
<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c) To about 2 cm³ of liquid P add 1 spatula measure of sodium</td>
<td></td>
</tr>
<tr>
<td>carbonate. Test the gas given off.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) By using a teat pipette add aqueous silver nitrate to about</td>
<td>white precipitate</td>
</tr>
<tr>
<td>1 cm³ of liquid P.</td>
<td></td>
</tr>
<tr>
<td>(e) By using a teat pipette add liquid Q to about 1 cm³ of aqueous</td>
<td></td>
</tr>
<tr>
<td>iron(II) sulphate.</td>
<td></td>
</tr>
</tbody>
</table>

(f) Name the gas given off in test (b)(i).                           |
[1]                                                                    |

(g) Name the gas given off in test (c).                               |
[1]                                                                    |

(h) Identify liquid P.                                                |
[1]                                                                    |

(i) What conclusions can you draw about liquid R?                     |
[2]                                                                    |

[Total: 14]
4 A student investigated the reaction between potassium manganate(VII) and a metallic salt solution.

Two experiments were carried out.

Experiment 1

(a) About 1 cm$^3$ of aqueous sodium hydroxide was added to a little of the salt solution A and the observation noted.

observation  

green precipitate formed

(b) A burette was filled with potassium manganate(VII) solution up to the 0.0 cm$^3$ mark. By using a measuring cylinder, 25 cm$^3$ of solution A of the salt was placed into a conical flask. The flask was shaken to mix the contents. The potassium manganate(VII) solution was added to the flask, and shaken to mix thoroughly. Addition of potassium manganate(VII) solution was continued until there was a pale pink colour in the contents of the flask.

Use the burette diagram to record the volume in the table and complete the column.

![Burette Diagram]

Experiment 2

(c) Experiment 1(b) was repeated using a different solution B of the salt, instead of solution A. Use the burette diagrams to record the volumes in the table and complete the table.

![Burette Diagrams]
(d) About 1 cm³ of aqueous sodium hydroxide was added to a little of the solution in the flask and the observation noted.

observation  
red-brown precipitate

Table of results

Burette readings/cm³

<table>
<thead>
<tr>
<th></th>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>final reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>initial reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>difference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[4]

(e) (i) In which Experiment was the greatest volume of potassium manganate(VII) solution used?

.............................................................................................................................................. [1]

(ii) Compare the volumes of potassium manganate(VII) solution used in Experiments 1 and 2.

..............................................................................................................................................  [2]

(iii) Suggest an explanation for the difference in the volumes.

..............................................................................................................................................  [2]

(f) Predict the volume of potassium manganate(VII) solution which would be needed to react completely with 50 cm³ of solution B.

..............................................................................................................................................  [2]
(g) Explain one change that could be made to the experimental method to obtain more accurate results.

change .................................................................................................................. [2]

explanation ........................................................................................................... [2]

(h) What conclusion can you draw about the salt solution from

(i) experiment 1(a),

........................................................................................................................... [1]

(ii) experiment 2(d)?

........................................................................................................................... [1]

08s6

5 Two different solids, T and V, were analysed. T was a calcium salt. The tests on the solids and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>tests on solid T</td>
<td></td>
</tr>
<tr>
<td>(a) Appearance of solid T.</td>
<td>white solid</td>
</tr>
<tr>
<td>(b) A little of solid T was dissolved in distilled water. The solution was divided into three test-tubes.</td>
<td></td>
</tr>
<tr>
<td>(i) The pH of the first portion of the solution was tested.</td>
<td>colour</td>
</tr>
<tr>
<td></td>
<td>pH</td>
</tr>
<tr>
<td>(ii) To the second portion of solution was added excess aqueous sodium hydroxide.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii) To the third portion of solution was added excess ammonia solution.</td>
<td></td>
</tr>
<tr>
<td>tests on solid V</td>
<td>observations</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>(c) Appearance of solid V.</td>
<td>green crystals</td>
</tr>
<tr>
<td>(d) A little of solid V was dissolved in distilled water. The solution was divided into three test-tubes. The smell of the solution was noted.</td>
<td>smells of vinegar</td>
</tr>
<tr>
<td>(i) Test (b)(i) was repeated using the first portion of solution.</td>
<td>colour orange</td>
</tr>
<tr>
<td>(ii) Test (b)(ii) was repeated using the second portion of the solution.</td>
<td>pH 6</td>
</tr>
<tr>
<td>(iii) Test (b)(iii) was repeated using the third portion of solution.</td>
<td>pale blue precipitate</td>
</tr>
<tr>
<td></td>
<td>pale blue precipitate soluble in excess to form a dark blue solution.</td>
</tr>
</tbody>
</table>

(e) What do tests (b)(i) and (d)(i) tell you about solutions T and V?  
................................................................................................................................................. [2]

(f) What additional conclusions can you draw about solid V?  
................................................................................................................................................. [2]  
[Total: 6]
Two salt solutions $K$ and $L$ were analysed. Each contained the same chloride anion but different metal cations. $K$ was a copper(II) salt. The tests on the solutions and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Appearance of the solutions.</td>
<td></td>
</tr>
<tr>
<td>solution $K$</td>
<td>..........................................................[1]</td>
</tr>
<tr>
<td>solution $L$</td>
<td>yellow</td>
</tr>
<tr>
<td>(b) The pH of each solution was tested.</td>
<td></td>
</tr>
<tr>
<td>solution $K$</td>
<td>pH 3</td>
</tr>
<tr>
<td>solution $L$</td>
<td>pH 2</td>
</tr>
</tbody>
</table>

**Tests on solution $K$**

<table>
<thead>
<tr>
<th>(c) (i) Drops of aqueous sodium hydroxide were added to solution $K$. Excess aqueous sodium hydroxide was then added to the test-tube.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>..........................................................[2]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(ii) Experiment (c)(i) was repeated using aqueous ammonia instead of aqueous sodium hydroxide.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>drops</td>
<td>..........................................................[1]</td>
</tr>
<tr>
<td>excess</td>
<td>..........................................................[2]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(iii) A few drops of hydrochloric acid and about 1 cm$^3$ of barium chloride solution were added to a little of solution $K$.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>..........................................................[1]</td>
</tr>
</tbody>
</table>
### Tests on Solution L

<table>
<thead>
<tr>
<th>Tests</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(iv) A few drops of nitric acid and about 1 cm³ of silver nitrate solution were added to a little of solution K.</td>
<td>[1]</td>
</tr>
<tr>
<td><strong>Tests on Solution L</strong></td>
<td></td>
</tr>
<tr>
<td>(d) (i) Experiment (c)(i) was repeated using solution L.</td>
<td>red - brown precipitate</td>
</tr>
<tr>
<td>(ii) Experiment (c)(ii) was repeated using solution L.</td>
<td>red - brown precipitate</td>
</tr>
<tr>
<td>(iii) Experiment (c)(iii) was repeated using solution L.</td>
<td>[1]</td>
</tr>
<tr>
<td>(iv) Experiment (c)(iv) was repeated using solution L.</td>
<td>[1]</td>
</tr>
</tbody>
</table>

(e) What does test (b) indicate?  
[1]

(f) Identify the metal cation present in solution L.  
[2]

[Total: 13]
An experiment was carried out to determine the solubility of potassium chlorate at different temperatures. The solubility is the mass of potassium chlorate that dissolves in 100 g of water. The results obtained are shown in the table below.

<table>
<thead>
<tr>
<th>temperature/°C</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>solubility in g/100 g water</td>
<td>14</td>
<td>17</td>
<td>20</td>
<td>24</td>
<td>29</td>
<td>34</td>
<td>40</td>
</tr>
</tbody>
</table>

(a) On the grid, draw a smooth line graph to show the solubility of potassium chlorate at different temperatures.

(b) Use your graph to determine the solubility of potassium chlorate at 70 °C. Show clearly on the graph how you obtained your answer.

(c) What would be the effect of cooling a saturated solution of potassium chlorate from 60 °C to 20 °C?

[Total: 8]
7 A solution of magnesium sulphate can be made by reacting magnesium oxide with warm sulphuric acid.

(a) Describe how you could make a solution of magnesium sulphate starting with magnesium oxide powder and dilute sulphuric acid.

................................................................................................................................................. [3]

(b) Describe how you would obtain pure dry crystals of hydrated magnesium sulphate, \( \text{MgSO}_4 \cdot 7\text{H}_2\text{O} \), from the solution of magnesium sulphate in (a).

................................................................................................................................................. [3]

[Total: 6]
Two solids, S and V, were analysed. S was copper(II) oxide. The tests on the solids, and some of the observations are in the following table. Complete the observations in the table. Do not write any conclusions in the table.

<table>
<thead>
<tr>
<th>test</th>
<th>observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>tests on solid S</td>
<td></td>
</tr>
<tr>
<td>(a) Appearance of solid S</td>
<td>black solid</td>
</tr>
<tr>
<td>(b) Hydrogen peroxide was added to solid S in a test-tube. A glowing splint was inserted into the tube.</td>
<td>slow effervescence</td>
</tr>
<tr>
<td></td>
<td>splint relit</td>
</tr>
<tr>
<td>(c) Dilute sulfuric acid was added to solid S in a test-tube. The mixture was heated to boiling point. The solution was divided into three equal portions into test-tubes.</td>
<td>blue solution formed</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>To the first portion of the solution, excess sodium hydroxide was added.</td>
</tr>
<tr>
<td></td>
<td>To the second portion of the solution, about 1 cm$^3$ of aqueous ammonia solution was added.</td>
</tr>
<tr>
<td></td>
<td>Excess ammonia solution was then added.</td>
</tr>
<tr>
<td></td>
<td>To the third portion of the solution, dilute hydrochloric acid was added followed by barium chloride solution.</td>
</tr>
<tr>
<td>test</td>
<td>observation</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>tests on solid V</td>
<td></td>
</tr>
<tr>
<td>(d) Appearance of solid V</td>
<td>black solid</td>
</tr>
<tr>
<td>(e) Hydrogen peroxide was added to solid V in a test-tube. A glowing splint was inserted into the tube.</td>
<td>rapid effervescence splint relit</td>
</tr>
</tbody>
</table>

(f) (i) Compare the reactivity of solid S and solid V with hydrogen peroxide.  
........................................................................................................................................... [1]

(ii) Identify the gas given off in test (e).  
........................................................................................................................................... [1]

(g) What conclusions can you draw about solid V?  
...........................................................................................................................................  
...........................................................................................................................................  
........................................................................................................................................... [2]

[Total: 11]
6 Acid base indicators

Indicators are used to identify acids and bases. Indicators can be obtained from berries and other fruits.

(a) Plan an experiment to obtain an aqueous solution of an indicator from some berries.

(b) Plan an experiment to use the indicator solution to show that it is an effective indicator.

[Total: 6]
3 Describe a chemical test to distinguish between each of the following pairs of substances. An example is given.

Example: hydrogen and carbon dioxide

   test lighted splint
   result with hydrogen gives a pop
   result with carbon dioxide splint is extinguished

(a) zinc carbonate and zinc chloride

   test .................................................................
   result with zinc carbonate ...........................................
   result with zinc chloride ...........................................  [2]

(b) ammonia and chlorine

   test .................................................................
   result with ammonia ................................................
   result with chlorine ................................................  [3]

(c) aqueous iron(II) sulfate and aqueous iron(III) sulfate

   test .................................................................
   result with aqueous iron(II) sulfate ................................
   result with aqueous iron(III) sulfate .............................  [3]

[Total: 8]
The apparatus below was used to make oxygen. The tube of manganese oxide was added to the hydrogen peroxide solution by releasing the cotton.

(a) Complete the boxes to identify the pieces of apparatus. [2]

(b) Why was the tube of manganese oxide suspended in the flask? .................................................................................................................................................................................................................................................................................................................. [1]

(c) Give a test for oxygen.

   test ..................................................................................................................................................................................................................................................................................................................

   result .................................................................................................................................................................................................................................................................................................................. [2]

[Total: 5]
Three aqueous solutions K, L and M, were analysed. L was a solution of sodium hydroxide. The tests on the solutions and some of the observations are in the table. Complete the observations in the table. Do not write any conclusions in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Appearance of the solutions.</td>
<td></td>
</tr>
<tr>
<td>solution K</td>
<td>colourless liquid</td>
</tr>
<tr>
<td>solution L</td>
<td>colourless liquid</td>
</tr>
<tr>
<td>solution M</td>
<td>colourless liquid</td>
</tr>
<tr>
<td>(b) Universal Indicator paper was used to test the pH of each solution.</td>
<td></td>
</tr>
<tr>
<td>solution K</td>
<td>pH 10</td>
</tr>
<tr>
<td>solution L</td>
<td>pH .......... [1]</td>
</tr>
<tr>
<td>solution M</td>
<td>pH 2</td>
</tr>
<tr>
<td>(c) tests on solution K</td>
<td></td>
</tr>
<tr>
<td>(i) Drops of solution K were added to copper sulfate solution in a test-tube. Excess of solution K was then added to the test-tube.</td>
<td>pale blue precipitate formed</td>
</tr>
<tr>
<td>(ii) Experiment (c)(i) was repeated using aqueous aluminium sulfate instead of aqueous copper sulfate.</td>
<td>white precipitate formed</td>
</tr>
<tr>
<td>(iii) A few drops of nitric acid and silver nitrate solution were added to solution K.</td>
<td>no visible reaction</td>
</tr>
<tr>
<td>(d) tests on solution L</td>
<td></td>
</tr>
<tr>
<td>(i) Experiment (c)(i) was repeated using solution L.</td>
<td>.................................................. [1]</td>
</tr>
<tr>
<td>(ii) Experiment (c)(ii) was repeated using solution L.</td>
<td>.................................................. [3]</td>
</tr>
<tr>
<td>(e) test on solution M</td>
<td></td>
</tr>
<tr>
<td>Experiment (c)(iii) was repeated using solution M.</td>
<td>white precipitate formed</td>
</tr>
</tbody>
</table>
(f) What conclusions can you make about solution K?

[2]

(g) What conclusions can you make about solution M?

[2]

[Total: 9]

3 Three unlabelled bottles of chemicals each contained one of the following liquids:

- sodium nitrate dissolved in water;
- pure water;
- hexene.

(a) Give a test by which you could identify sodium nitrate solution.

<table>
<thead>
<tr>
<th>test</th>
<th>result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[2]

(b) Give a test by which you could identify pure water.

<table>
<thead>
<tr>
<th>test</th>
<th>result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[2]
Solid E was analysed. E was an aluminium salt. The tests on the solid and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests on solid E</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Appearance of solid E.</td>
<td>white crystalline solid</td>
</tr>
<tr>
<td>(b) A little of solid E was heated in a test-tube.</td>
<td>colourless drops of liquid formed at the top of the tube</td>
</tr>
<tr>
<td>(c) A little of solid E was dissolved in distilled water. The solution was divided into four test-tubes and the following tests were carried out.</td>
<td></td>
</tr>
<tr>
<td>(i) To the first test-tube of solution, drops of aqueous sodium hydroxide were added. Excess sodium hydroxide was then added to the test-tube.</td>
<td>..........................................................</td>
</tr>
<tr>
<td>(ii) Test (i) was repeated using aqueous ammonia solution instead of aqueous sodium hydroxide.</td>
<td>..........................................................  [3]</td>
</tr>
<tr>
<td>(iii) To the third test-tube of solution, dilute hydrochloric acid was added, followed by barium chloride solution.</td>
<td>..........................................................  [2]</td>
</tr>
<tr>
<td>(iv) To the fourth test-tube of solution, aqueous sodium hydroxide and aluminium powder were added. The mixture was heated.</td>
<td>no reaction effervescence pungent gas given off turned damp litmus paper blue</td>
</tr>
</tbody>
</table>
(d) What does test (b) tell you about solid E?

........................................................................................................................................... [1]

(e) Identify the gas given off in test (c)(iv).

........................................................................................................................................... [1]

(f) What conclusions can you draw about solid E?

........................................................................................................................................... [2]

[Total: 9]

10w6

2 The following instructions were used to prepare magnesium sulfate crystals, MgSO₄·7H₂O.

Step 1 Measure 50 cm³ of dilute sulfuric acid into a beaker and warm the solution.

Step 2 Using a spatula, add some magnesium oxide and stir the mixture. Continue adding the magnesium oxide until excess is present.

Step 3 Separate the excess magnesium oxide from the solution of magnesium sulfate.

Step 4 Heat the solution until crystals form. Obtain the crystals and dry them.

(a) Why is the sulfuric acid warmed?

........................................................................................................................................... [1]

(b) How would you know when excess magnesium oxide is present in Step 2?

........................................................................................................................................... [1]

(c) What method is used in Step 3?

........................................................................................................................................... [1]

(d) Why must care be taken when drying the crystals in Step 4?

........................................................................................................................................... [1]

(e) Explain how the method would differ if magnesium carbonate was used instead of magnesium oxide.

........................................................................................................................................... [2]
5 Two different solutions, X and Y, were analysed. X was copper sulfate solution.
The tests on the solutions, and some of the observations, are in the following table.

Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>tests on solution X</strong></td>
<td></td>
</tr>
<tr>
<td><strong>(a)</strong> (i) Appearance of solution X.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[1]</td>
</tr>
<tr>
<td>(ii) To a little of solution X, aqueous sodium hydroxide was added.</td>
<td>[2]</td>
</tr>
<tr>
<td>(iii) To a little of solution X, aqueous ammonia was added drop by drop and shaken.</td>
<td>[1]</td>
</tr>
<tr>
<td>Excess aqueous ammonia solution was then added to the test-tube.</td>
<td>[2]</td>
</tr>
<tr>
<td><strong>tests on solution Y</strong></td>
<td></td>
</tr>
<tr>
<td><strong>(b)</strong> (i) A little of solution Y was tested with Universal indicator paper. The pH was recorded.</td>
<td>pH1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) To about 3 cm³ of solution Y a few drops of dilute hydrochloric acid and then aqueous barium chloride was added.</td>
<td>white precipitate</td>
</tr>
<tr>
<td><strong>(c)</strong> Identify solution Y.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2]</td>
</tr>
</tbody>
</table>

[Total: 8]
7 E numbers identify chemicals which are added to foods.

(a) E210 is benzoic acid. How could you show that a solution of benzoic acid is a weak acid?

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

Result ........................................................................ [2]

(b) E211 is sodium benzoate. Name a suitable substance that would react with a solution of benzoic acid to form sodium benzoate.

............................................................................... [1]

(c) E110 is Sunset yellow.
Outline a method you could use to show the presence of E110 in a food colouring.
A space has been left if you want to draw a diagram to help you answer the question.

..............................................................................
..............................................................................
..............................................................................
.............................................................................. [4]

[Total: 7]
Two different liquids, \( M \) and \( N \), were analysed. \( N \) was aqueous potassium iodide. The tests on the liquids and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) (i) Appearance of liquid ( M ).</td>
<td>colourless liquid with an antiseptic smell</td>
</tr>
<tr>
<td>(ii) Appearance of liquid ( N ).</td>
<td>.......................................................... [2]</td>
</tr>
<tr>
<td>(b) (i) A few drops of ( M ) were transferred to a dry watch glass. The liquid was touched with a lighted splint.</td>
<td>burns with a yellow flame</td>
</tr>
<tr>
<td>(ii) Test (b)(i) was repeated using liquid ( N ).</td>
<td>.......................................................... [1]</td>
</tr>
<tr>
<td>(c) A little of liquid ( M ) was added to a crystal of iodine in a test-tube. The test-tube was shaken.</td>
<td>orange-brown solution</td>
</tr>
<tr>
<td>(d) To a little of liquid ( N ), a few drops of dilute nitric acid was added, followed by silver nitrate solution.</td>
<td>.......................................................... [2]</td>
</tr>
<tr>
<td>(e) What type of substance is liquid ( M )?</td>
<td>.......................................................... [2]</td>
</tr>
</tbody>
</table>

[Total: 7]
The reaction between aqueous barium chloride and aqueous sodium sulfate produces a white precipitate. Six experiments were carried out to find the mass of precipitate produced using solution P and solution Q.

Solution P was aqueous barium chloride. Solution Q was aqueous sodium sulfate. Both solutions were of the same concentration.

5 cm$^3$ of solution P was put into each of six test tubes. Increasing volumes of solution Q were added to each test tube. The mixtures were filtered to obtain the precipitates, which were washed, dried and then weighed in a suitable container.

(a) Draw a labelled diagram to show how the mixture was filtered.

The results are shown in the table below.

(b) Complete the table.

<table>
<thead>
<tr>
<th>volume of P/cm$^3$</th>
<th>volume of Q/cm$^3$</th>
<th>mass of container/g</th>
<th>mass of container and precipitate/g</th>
<th>mass of precipitate/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>4.50</td>
<td>4.95</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>4.50</td>
<td>5.45</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>4.50</td>
<td>5.90</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>4.50</td>
<td>6.40</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>4.50</td>
<td>6.85</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>4.50</td>
<td>6.85</td>
<td></td>
</tr>
</tbody>
</table>
(c) Plot the points on the grid below. Join the points with two intersecting straight lines.

(d) What is the minimum volume of Q required to completely react with 5 cm$^3$ of P?
2 A student prepared a sample of potassium nitrate by neutralising nitric acid using potassium hydroxide solution. 25.0 cm$^3$ of nitric acid was poured into a conical flask. Potassium hydroxide was added a little at a time from a burette as shown below.

![Diagram of potassium hydroxide solution and nitric acid in a conical flask.]

After each addition of potassium hydroxide solution the pH was measured with a pH meter and the values recorded in the table of results.

<table>
<thead>
<tr>
<th>volume of potassium hydroxide solution added/cm$^3$</th>
<th>pH value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>1.2</td>
</tr>
<tr>
<td>10.0</td>
<td>1.4</td>
</tr>
<tr>
<td>15.0</td>
<td>2.6</td>
</tr>
<tr>
<td>20.0</td>
<td>2.0</td>
</tr>
<tr>
<td>24.0</td>
<td>2.7</td>
</tr>
<tr>
<td>24.5</td>
<td>3.0</td>
</tr>
<tr>
<td>25.5</td>
<td>11.0</td>
</tr>
<tr>
<td>26.0</td>
<td>11.3</td>
</tr>
<tr>
<td>30.0</td>
<td>12.0</td>
</tr>
<tr>
<td>40.0</td>
<td>13.2</td>
</tr>
</tbody>
</table>

You are going to draw a graph to find the volume of potassium hydroxide solution required to neutralise the 25.0 cm$^3$ of nitric acid.
(a) Plot the results on the grid below and draw a smooth line graph.

(b) Which point appears to be inaccurate?

(c) (i) Use your graph to find the pH of the solution when 35.0 cm$^3$ of potassium hydroxide was added.

(ii) Use your graph to find the pH of 25.0 cm$^3$ of nitric acid.

Show clearly on the grid how you obtained your answer.
(d) (i) What is the pH of the solution when all of the nitric acid has just been neutralised?

........................................................................................................................................... [1]

(ii) What volume of potassium hydroxide was required to neutralise 25.0 cm$^3$ of nitric acid?

........................................................................................................................................... [1]

(e) Describe how the student should modify the experiment to obtain pure crystals of potassium nitrate.

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

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

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

........................................................................................................................................... [3]

[Total: 12]
Three different liquids P, Q and R were analysed. P was an aqueous solution of sulfuric acid. The tests on the liquids and some of the observations are in the following table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) (i) Appearance of the liquids.</td>
<td>P .............................................. [1]</td>
</tr>
<tr>
<td></td>
<td>Q  colourless, smell of vinegar</td>
</tr>
<tr>
<td></td>
<td>R  colourless, no smell</td>
</tr>
<tr>
<td>(ii) The pH of the liquids was tested using Universal Indicator paper.</td>
<td>P .............................................. [1]</td>
</tr>
<tr>
<td></td>
<td>Q  pH5</td>
</tr>
<tr>
<td></td>
<td>R  pH7</td>
</tr>
<tr>
<td>(b) A piece of magnesium ribbon was added to a little of each liquid. The gas given off by liquid P was tested.</td>
<td>P .............................................. [2]</td>
</tr>
<tr>
<td></td>
<td>Q  slow effervescence</td>
</tr>
<tr>
<td></td>
<td>R  no reaction</td>
</tr>
<tr>
<td>(c) To a little of liquid P, hydrochloric acid and aqueous barium chloride were added.</td>
<td>.............................................. [2]</td>
</tr>
<tr>
<td>(d) Liquid R was heated to boiling in a test-tube. A thermometer was used to record the constant temperature of the vapour produced.</td>
<td>temperature = 100 °C</td>
</tr>
</tbody>
</table>

(e) What conclusions can you draw about liquid Q?

............................................................................................................................. [2]

(f) Identify liquid R.

............................................................................................................................. [1]

[Total: 9]
A student prepared a sample of potassium nitrate by neutralising nitric acid using potassium hydroxide solution. 25.0 cm$^3$ of nitric acid was poured into a conical flask. Potassium hydroxide was added a little at a time from a burette as shown below.

After each addition of potassium hydroxide solution the pH was measured with a pH meter and the values recorded in the table of results.

<table>
<thead>
<tr>
<th>volume of potassium hydroxide solution added/cm$^3$</th>
<th>pH value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>1.2</td>
</tr>
<tr>
<td>10.0</td>
<td>1.4</td>
</tr>
<tr>
<td>15.0</td>
<td>2.6</td>
</tr>
<tr>
<td>20.0</td>
<td>2.0</td>
</tr>
<tr>
<td>24.0</td>
<td>2.7</td>
</tr>
<tr>
<td>24.5</td>
<td>3.0</td>
</tr>
<tr>
<td>25.5</td>
<td>11.0</td>
</tr>
<tr>
<td>26.0</td>
<td>11.3</td>
</tr>
<tr>
<td>30.0</td>
<td>12.0</td>
</tr>
<tr>
<td>40.0</td>
<td>13.2</td>
</tr>
</tbody>
</table>

You are going to draw a graph to find the volume of potassium hydroxide solution required to neutralise the 25.0 cm$^3$ of nitric acid.
(a) Plot the results on the grid below and draw a smooth line graph.

(b) Which point appears to be inaccurate?

(c) (i) Use your graph to find the pH of the solution when 35.0 cm$^3$ of potassium hydroxide was added.

(ii) Use your graph to find the pH of 25.0 cm$^3$ of nitric acid.

Show clearly on the grid how you obtained your answer.
1 A student reacted excess iron powder with sulfuric acid to prepare a solution of iron(II) sulfate. The diagram shows the procedure followed in three stages.

2 iron powder was added until all the sulfuric acid had reacted

1 50 cm$^3$ of dilute sulfuric acid was measured and added to a beaker

3 the mixture was allowed to cool

(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

(b) How would the student know when all of the sulfuric acid had reacted? Give two reasons.

1 ............................................................................................................................................. [2]

2 .............................................................................................................................................

(c) Describe the effect of boiling the solution of iron(II) sulfate for several minutes.

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

............................................................................................................................................. [3]

[Total: 7]
5 Solid W was analysed. W was a carbonate salt.
The tests on solid W, and some of the observations, are in the following table. Complete the observations in the table.
Do not write any conclusions in the table.

<table>
<thead>
<tr>
<th>tests on solid W</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(a)</strong> Appearance of solid W.</td>
<td>white solid</td>
</tr>
<tr>
<td><strong>(b)</strong> Solid W was heated.</td>
<td>gas evolved formed a white solid at the top of the test-tube</td>
</tr>
<tr>
<td></td>
<td>litmus paper turned blue</td>
</tr>
<tr>
<td><strong>(c)</strong> Dilute hydrochloric acid was added to solid W.</td>
<td>[ ]</td>
</tr>
<tr>
<td></td>
<td>The gas given off was tested.</td>
</tr>
<tr>
<td></td>
<td>[ ]</td>
</tr>
<tr>
<td></td>
<td>[ ] [3]</td>
</tr>
<tr>
<td><strong>(d)</strong> Dilute sodium hydroxide was added to solid W and the mixture heated.</td>
<td>pungent gas given off</td>
</tr>
<tr>
<td></td>
<td>The gas given off was tested with damp pH indicator paper.</td>
</tr>
<tr>
<td></td>
<td>pH of gas = 10</td>
</tr>
</tbody>
</table>

(e) Identify the gas given off in test (d).

................................................................................................................................................... [1]

(f) What conclusions can you draw about solid W?

................................................................................................................................................... [2]

[Total: 6]
4. A student investigated the reaction between aqueous lead nitrate and aqueous potassium chloride.

(a) One experiment was carried out.

Using a measuring cylinder, 3 cm$^3$ of aqueous lead nitrate was poured into each of six test-tubes in a test-tube rack. The test-tubes were labelled A, B, C, D, E and F respectively.

A burette was filled with aqueous potassium chloride. A 1.0 cm$^3$ sample of the aqueous potassium chloride was added to test-tube A. A 2.0 cm$^3$ sample of aqueous potassium chloride was added to test-tube B. A 4.0 cm$^3$, 6.0 cm$^3$, 6.0 cm$^3$ and 7.0 cm$^3$ sample of aqueous potassium chloride was added to test-tubes C, D, E and F respectively.

Using a glass rod, the contents of the test-tubes were stirred. The contents of the test-tubes were left to stand for 10 minutes.

After 10 minutes, a ruler was used to measure the height of the solid in each test-tube. The diagrams show the six test-tubes in a rack. Use a ruler to measure the height of the solid in each test-tube in the diagram. Record the heights of the solid in the table.

<table>
<thead>
<tr>
<th>test-tube number</th>
<th>volume of aqueous potassium chloride/cm$^3$</th>
<th>height of solid/mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(b) Plot your results on the grid below. Draw two intersecting straight line graphs.

(c) From your graph, find the height of the solid formed when 3.5 cm³ of aqueous potassium chloride was added to 3 cm³ of aqueous lead nitrate. Show clearly on the graph how you obtained your answer.

(d) What type of chemical reaction occurs when aqueous potassium chloride reacts with aqueous lead nitrate?

(e) (i) Compare the heights of the solids in test-tubes E and F.

(ii) Suggest an explanation for the heights of the solids in (e)(i).
(f) Predict what would happen if the experiment were continued using three further test-tubes with 8 cm$^3$, 9 cm$^3$ and 10 cm$^3$ of aqueous potassium chloride. Explain your answer.

................................................................................................................................................................. [2]

(g) What difference would be observed if the experiment was repeated using aqueous silver nitrate and aqueous potassium iodide?

................................................................................................................................................................. [1]

(h) Explain one improvement the student could make to the experiment to obtain more accurate results.

improvement .................................................................................................................................................. [2]

explanation ...................................................................................................................................................... [2]

[Total: 19]
A mixture of two solids, \( M \) and \( N \), was analysed. Solid \( M \) was zinc sulfate which is water-soluble and solid \( N \) was insoluble. The tests on the mixture, and some of the observations, are in the table. Complete the observations in the table.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distilled water was added to the mixture in a boiling tube and shaken. The contents of the tube were filtered and the filtrate and residue kept for the following tests.</td>
<td></td>
</tr>
<tr>
<td>tests on the filtrate</td>
<td></td>
</tr>
<tr>
<td>The filtrate was divided into four portions.</td>
<td></td>
</tr>
<tr>
<td>(a) (i) Drops of aqueous sodium hydroxide were added to the first portion of the filtrate. Excess aqueous sodium hydroxide was then added.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Drops of aqueous ammonia were added to the second portion of the filtrate. Excess aqueous ammonia was then added.</td>
<td>[3]</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) About 1 cm(^3) of dilute nitric acid followed by silver nitrate solution was added to the third portion of the filtrate.</td>
<td>[1]</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) About 1 cm(^3) of dilute nitric acid followed by barium nitrate solution was added to the fourth portion of the filtrate.</td>
<td>[2]</td>
</tr>
<tr>
<td>tests</td>
<td>observations</td>
</tr>
<tr>
<td>-------</td>
<td>--------------</td>
</tr>
<tr>
<td><strong>tests on the residue</strong></td>
<td></td>
</tr>
<tr>
<td>(d) Appearance of the residue.</td>
<td>black solid</td>
</tr>
<tr>
<td>(e) Dilute hydrochloric acid was added to a little of the residue. The mixture was heated and the gas given off was tested with damp blue litmus paper.</td>
<td>effervescence pungent gas, bleached litmus paper</td>
</tr>
<tr>
<td>(f) Aqueous hydrogen peroxide was added to a little of the residue. The gas given off was tested.</td>
<td>effervescence glowing splint relit</td>
</tr>
</tbody>
</table>

(g) Identify the gas given off in test (e). 

........................................................................................................................................ [1] 

(h) Identify the gas given off in test (f). 

........................................................................................................................................ [1] 

(i) What conclusions can you draw about solid N? 

........................................................................................................................................ [2] 

[Total: 12]
Mark Scheme

01w6

1(a) Boxes completed to show beaker (1), pipette (1), burette (1) [3]
(b) indicator (1), colour change (1) [2]
(c) repeat the experiment / pH meter [1]
[Total 6]

01w6

5(a)(i) green (1) precipitate (1) [max 2]
(b) red / brown (1) precipitate (1) [2]
(c) green (1) precipitate (1)
brown (1) [2]
(e) ammonia [1]
(f) ammonium [1]
(g) sulphate [1]
[Total 10]

02s6

1(a) 1 — (Thistle) funnel (1)
  b — (conical) flask (1)
  c — jar (1)
  (b) → ml Thistle funnel (1)
  (c) limewater (1) milky (1) not start last—2

02s6

2(a)(i) red / pink (1)
  (ii) clear of drink interface or similar (1) [1]
  (b) heat (1) condenser (1) / distillation (2)
  / boiler / engine
6 (a) Blue (1) precipitate (1)
   (i) Blue precipitate (1) dissolves in ethanol
   deep/royal blue (1)
   (b) Oxygen (1) /O₂
   (c) Chlorine (1) /Cl₂
   (d) Catalyst /oxidising agent (1)
   Transition metal /manganese (2) min. 2
   MnO₂ = (2)

02s6

3 (a) To keep magnesium out of contact with acid or water (1)
   (i) To measure volume of gas (1) not collected (1)
   (b) Shake the flask/let go cotton (1)

02s6

7 (a) eg Indicators (1)
   Result (1)
   Red in acid, no change in NaCl (1)
   (b) eg Bromine (1)
   D dissolved in propanol, stays same in propanol (1)
   (c) Barium chloride (1)
   White precipitate in H₂SO₄ (1)
   No change in H₂O (1)

02w6
1. A = spatula only (1)
   B = beaker only (1)
   C = funnel (1) not filter

   (1) more than enough to react (1)
     residue
   (2) 6-7 (1)

5. (c) catches fire / ignites (1) yellow / blue flame (1) smoky
   (1) yellow (1) precipitate (1)
     cream
   (c) white (1) precipitate (1)
     yellow
   (f) organic (1) hydration (1)
     alkane / alkene (1)

02w6
6 (a) Pipette / burette (i)

(b) Name (i) 

- Universal indicator, litmus
- Methyl orange
- Phenolphthalein

- Color change (i) 
  - Yellow to orange / pink (i)
  - Pink (i) to colorless (i)

- Solution (i) 
  - Purple / red

- The acid (i) less needed to neutralize the KOH (i)

(d) Repeat experiment (i)

- Without indicator (i) / observe
- Evaporate solution (i)

- By crystallizing point (ii) max 3

max indicator + max 2

Cotton

---

2 (a) Top box - Sulphuric acid (i)

- Bottom box - Sodium chloride (i)

(b) Gas passed through water (i)

- Gas is soluble in water (i)

- Gas collected by upward delivery (i)

- Gas in denser than air (i)

(c) Same cupboard / goggles (i)

- Well ventilated room / gloves
4. (c) effervescence/fizz/bubbles (1)
   limewater milky (1)/blue solution (1)
   [2]

   (d) (ii) blue (1) precipitate (1)
          royal/dark blue (1) solution (1)
          [4]

   (e) (i) white (1) precipitate (1)
          dissolves (1)
          [3]

   (ii) white (1) precipitate (1)
        dissolves (1)
        [3]

   (f) Solid D is a sulphate (1) hydrated (1)
       [2]

   (g) copper (1)Cu²⁺ (2)
       [2]

---

6

Known mass of beach sand (1)
add excess (1) dilute hydrochloric acid (1)
filter (1) wash (1) dry (1) residue
and weigh sand (1) working out result (1)
max 6 of 6

[6]

---

4. (b) (i) Orange/brown (1)
   Precipitate (1)
   No change in excess (1)
   [3]

   (c) Orange/brown precipitate (1)
       No change in excess (1)
       [2]

   (f) (i) Hydrogen (1)
       [1]

   (ii) Reduction/redox/displacement (1) Iron (1) formed (1)
       [2]

   (g) Cation – ammonium (1)
       Anion – sulphate (1)
       [2]

---

5. (a) Sodium hydroxide (1)
    [1]

   (b) Ammonium sulphate (1)
       [1]

   (c) Bunsen burner (1)
       [1]

   (d) Reference to reaction (1)
       [1]

   (e) Gas jar wrong way up (1)
       Gas is less dense than air (1)
       [2]

       Tubes in flask should be evened (1)
       Liquid would be transferred to gas jar (1)
       [2]

       Also credit in (c)

---

04s6

Page 147 of 160
5 (a) (i) White Precipitate 1 [2]
No change/white precipitate/insoluble in excess 1 [1]
(ii) No/thin precipitate/no reaction 1 [1]
(b) Ammonia 1 [1]
(c) Reference to limewater/test for carbon dioxide 1 [1]
(d) Nitrate 1
Alkal/hydroxide/oxide 1 [2]

04s6

4 Experiment 1 Temperatures correct 2 [2]
(-1 any incorrect)
Time/Min 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
Temp/°C 22 24 26 28 29 30 29 28 27 26
Experiment 2 Temperatures correct 2 [2]
(-1 any incorrect)
Time/Min 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
Temp/°C 21 19 17 15 14 13 13 14 15 16 17
(a) Graph Points plotted correctly 3
(-1 each incorrect)
Smooth lines/curve 2 [6]
Labelled 1
(b) (i) Temperature from graph 29.5°C 1
± 0.25°C
Temperature from graph 13.5°C 1 [2]
(ii) 1. Exothermic 1 [2]
2. Endothermic 1
(c) Carbonate 1
Flizz/gas with acid 1 [2]

(d) (i) 22°C 1
21°C 1
(ii) Reference to room temperature/reaction finished 1 [3]

04s6

7 (a) Anhydrous copper sulphate/cobalt chloride 1 [2]
Goes blue/pink in water, no change for ethanol 1
(b) Add indicator/named indicator or CO₂/Na₂O 1 [2]
Mg Turns red/correct colour in acid, no change for sodium sulphate 1 [2]
(c) Add silver nitrate 1
White precipitate with hydrochloric acid, no change with nitric acid 1 [2]

04w6
1. (a) A measuring cylinder (1)  
   B flask (1) (2)
(b) boxes completed correctly, zinc and hydrochloric acid (1) (1)
(c) lighted splint (1) pops (1)  
   second mark consequential i.e. glowing splint = 0 (2)

04w6

5. (a) white (1) crystals/solid (1) (2)
   (c) (i) white (1) precipitate (1) (2)
      (ii) white (1) precipitate (1) (2)
   (iii) reference to smell (1) alkaline/blue (1) pH 9 → 12 (1) z max (2)
   (d) ammonia (1) (1)
   (e) alkaline gas/ammonia given off (1)  
      acid gas/hydrogen chloride given off (1) (2)

04w6

6. (a) litmus/indicator (1)  
   bleached in chlorine, no effect with sodium chloride (1) (2)
(b) sodium hydroxide (1)  
   green (precipitate) with iron(II), brown (precipitate) with iron(III) (1) (2)
   (c) add hydrochloric acid (1)  
      fizz/bubbles with carbonate, no reaction with sulphate (1) (2)
      alternative with HCl and barium chloride (1)  
      white precipitate with sulphate, not carbonate (1)

05s6

4. table of results:  
   all initial and final volume boxes correctly completed 0.0, 10.6, 14.9, 36.1 (3)
   difference boxes correctly completed, 10.6, 21.2 (1) [4]
   (a) neutralisation (1) [1]
   (b) (i) experiment 2 (1) [1]
      (ii) experiment 2 more/greater volume (1) x 2 (1) [2]
      (iii) M more concentrated/stronger than N (1) x 2 (1) [2]
   (c) 21.2 (1) cm³ (1)  
      twice as much calcium hydroxide (1) [3]
   (d) e.g. use a pipette/burette instead of a measuring cylinder (1) [1]

05s6
5. (b) (i) fizz/bubbles (1)  pops (1) [2]
    (ii) fizz/bubbles (1) limewater milky (1) [2]
    (c) weak (1) [1]

(d) (i) hydrogen (1) [1]
    (ii) carbon dioxide (1) [1]
    (e) copper (1) 2+ (1) [2]

05s6

7. (a) straight line (1) DRAWN WITH A RULER [1]
    (b) inaccurate point is at pH 5 (1) not on line (1) [2]
    (c) % corrosion decreases as pH increases (1) [1]

05s6

4. table of results:
   all initial and final volume boxes correctly completed 0.0, 10.6, 14.9, 38.1 (3) [4]
   difference boxes correctly completed, 10.6, 21.2 (1) [4]

(b) (i) experiment 2 (1) [1]
    (ii) experiment 2 more/greater volume (1) × 2 (1) [2]
    (iii) M more concentrated/stronger than N (1) × 2 (1) [2]

05s6

6. (a) no/little water present/little water implied (1) [1]
    (b) any value less than 7 (1) [1]
    (c) chromatography (1) apply to paper (1) use of solvent (1) [4]
        description of two yellow spots (1)
        paper in drink = max 2

05s6

3. volumes from syringe diagrams;
   15, 45, 61, 73, 74, 80 and 80 all correct (4) (-1 for each incorrect) [4]
   (a) graph:
       all points plotted correctly (3) (-1 for each incorrect) smooth curve (1) [4]
   (b) volume of acid from graph, 10.5 → 11.5 (1) [1]
   (c) volume of hydrogen from graph, 29.5 → 30.5 (1) [1]

05w6
1  (a) boxes filled in correctly to show:
   measuring cylinder (1)
   spatula (1)
   beaker (1)

   (b) blue  [1]

   (c) heat (1)
   to crystallising point (1)  [2]

05w6

5  (b)  
   (i) white (1)
   precipitate (1)
   dissolves (1)  [3]

   (ii) white (1)
   precipitate (1)
   insoluble (1)  [3]

   (c) acid gas/named/hydrated salt  [1]

   (d) not a sulphate (1)
   not a halde (1)  [2]

   (e) ammonia  [1]

   (f) nitrate (1)
   hydrated water (1)  [2]

05w6

7  (a) soil sample + water (1)
   stir/heat (1)
   filter (1)
   add Universal Indicator (1)
   chart (1)  [5]

   (b) more samples (1)
   different parts of field (1)  [2]

06s6
5 (b) (i) white (1), precipitate (1), dissolves/soluble (1) [3]
   (ii) white (1), precipitate (1), dissolves/soluble (1) [3]
   (d) reference to water (1) e.g. hydrated salt [1]
   (e) sulphate (1), not a chloride (1) [2]
   (f) carbon dioxide (1), from a carbonate (1) [2]

06s6

6 Measured volume of oven cleaner (1)
   Acid indicator/named indicator (1)
   Acid named acid (1), from a burette/pipette (1)
   Until colour change/end point (1), measure/record volume of acid (1)
   Repeat with other cleaner (1), compare (1)

Max 6 [6]

06w6

1 (a) Boxes filled in correctly to show
   tongs(1)
   watch glass/evaporating basin/dish(1)
   beaker(1) [3]
   (b) oxidation/reduction/exothermic/redox(1) [1]
   (c) > 7(1) [1]

06w6

5 (a) (ii) red(1) litmus turns blue(1) reference to smell(1) max 2 [2]
   (c) weak(1) acid(1) [2]
   (d) ammonia(1) [1]
   (e) ammonium chloride(1) [1]
   (f) potassium iodide(1) [1]

07s6

5 (c) bubbles / fizz (1) limewater (1) milky (1) [3]
   (d) yellow (1) precipitate (1) [2]
   (f) carbon dioxide (1) [1]
   (g) ammonia (1) [1]
   (h) iron (1) (II) ammonium (1) sulphate (1) [4]

[Total: 11]
7 (a) initial temperature of cold water or cement (1) 
    add cement (1) 
    using thermometer / in beaker etc. (1) 
    measure temperature (1) 
    temperature rise (2) max 4 

NR 
no water = 0 
nocement = 0 
use of heat = 0 
wrong chemicals = 0 
would not work = 0 

(b) sodium hydroxide (1) white precipitate (1) 
    or flame test (1) red (1) 

[Total: 6]

07w6

3 (a) So that all acid is used up/neutralised (1) 

(b) filter (1) 

(c) (i) no more solid/solutes can dissolve (1) at that temperature (1) 

(ii) use a glass rod to show crystals forming/observe crystals forming on edge of solution (1) 

(d) to prevent breakdown of the crystals/not form powder/not lose water (1) 

07w6

5 (a) (i) Q blue/purple (1) 11–14 (1) 

(ii) Q no reaction/change (1) 
    R bubbles/fizz (1) 

(c) bubbles/fizz (1) 
    limewater (1) milky (1) 

(e) green (1) precipitate (1) 

(f) hydrogen (1) 

(g) carbon dioxide (1) 

(h) hydrochloric acid/HCl (1) 

(i) weak (1) acid (1) 

08s6
4 Table of results

**Experiment 1**
initial and final volume boxes correctly completed (1), 0.0 and 26.0

**Experiment 2**
initial and final volume boxes correctly completed (2), 16.0 and 29.0
differences completed correctly (1), 26.0 and 13.0

(e) (i) Experiment 1 (1) [1]
(ii) more in Experiment 1/greater volume (1) × 2 (1) [2]
(iii) solution A more concentrated/stronger than B (1) × 2 (1) [2]

(f) twice the volume value for Experiment 2/26 (1) cm³ (1) [2]

(g) change e.g. repeat titrations (1) or use a burette/pipette
    explanation e.g. average reading more accurate (1) instead of m/cylinder [2]

(h) (i) iron(II) ions present (1) [1]
(ii) iron(III) ions (1) [1]

[Total: 15]

08s6

5 Tests on solid T

(b) (ii) white (1) precipitate (1) insoluble in excess (1) [2]
(iii) no/slight (1) precipitate (1) max 4 for (ii) and (iii) [2]
    no reaction (1) only

(e) weak (1) acids (1) [2]

(f) copper present (1) ethanoic acid/organic salt (1) [2]

[Total: 8]

08w6
5 (a) solution K blue/green not precipitate [1]

(c) tests on solution K
   (i) blue (1) precipitate (1) [2]
   (ii) blue precipitate
deep blue (1) blue solution or precipitate dissolves (1) [2]
   (iii) no reaction/change/nothing [1]
   (iv) white precipitate [1]

(d) tests on solution L
   (iii) no reaction/change/nothing [1]
   (iv) white precipitate [1]

(e) acids [1]

(f) iron (1) (III) (1) or Fe$^{3+}$ (2) ignore anions [2]

[Total: 13]

08w6

6 (a) Points plotted correctly (3), –1 for each incorrect
    smooth curve (1) not a straight line [4]

(b) 47±1 or reading from graph (1) curve extrapolated on grid (1) [2]

(c) solid/crystals form owtie (1) 20g (1)
    not solubility decreases [2]

[Total: 8]

08w6

7 (a) heat/warm the acid (1)
    add excess oxide or description of no more solid reacting (1)
    filter/decant (1) [3]

(b) heat qualified e.g. to crystallising point or description of e.g. using glass rod/leave it to evaporate (1)
    cool to form crystals (1)
    filter off crystals (1)
    method of drying crystals e.g. pressed filter papers/oven at low temperature (1) [max 3]

[Total: 6]

09s6
5 tests on solid S

(c) (i) blue precipitate (1) [1]
(ii) blue (1) precipitate (1) [2]
dissolves/clears (1) deep royal blue (1) [2]
(iii) white (1) precipitate (1) [2]

(f) (i) V is more reactive or converse (1) [1]
(ii) oxygen (1) [1]

(g) catalyst/transition metal/manganese oxide any two points (2) [2]
V is a better catalyst = 2

09s6

6 (a) add water (1)
crush/mix/warm (1)
filter/decant or pipette off liquid/sieve (1) [3]

(b) add indicator solution to acid (and note colour) (1)
add indicator solution to alkali or named alkali (and note colour) (1) not base conclusion e.g. colours should be different write (1) [3]

09s6

3 (a) add dilute acid (1) fizz, no fizz (1) or correct chloride test [2]

(b) litmus paper/named indicator (1) turns blue (1) bleached (1) [3]

(c) sodium hydroxide/ammonia (solution) (1) green (precipitate) (1)
brown (precipitate) (1) [3]

09w6

1 (a) (conical) flask (1) (gas) syringe (1) [2]

(b) to stop loss of gas owtte/stop mixing so that they don’t react [1]

(c) glowing splint (1) relights (1)
lighted splint = 0 ignore ‘pops’ [2]

09w6

5 (b) pH of solution L 11-14 [1]

(d) (i) blue precipitate (1) both for one mark (soluble in excess = 0) [1]
(ii) white (1) precipitate (1)
dissolves/clears/soluble in excess (1) [3]

(c) weak (1) alkali/base (1) or ammonia (2) [2]

(d) hydrochloric acid (2)
or acid (1) chloride ion (1) not chlorine ion [2]
5 tests on solid E

(c) (i) white (1) precipitate (1) with excess dissolves/cleans/colourless (1) [3]

(ii) white precipitate (1) insoluble/no change (in excess) (1) [2]

(d) contains water/hydrated (1) [1]

(e) ammonia (1) not ammonium [1]

(f) nitrate (1) hydrated salt (1) not a sulfate (1) max [2]

10w6

2 (a) to speed up the reaction [1]

(b) solid visible crystals e.g. no more solid will dissolve [1]

(c) filtration / centrifuge not decant [1]

(d) to make sure water (of crystallisation) is not lost / stop dehydration / so crystals do not turn into powder / does not decompose not crystals break [1]

(e) no heat needed / not necessary to warm acid (1) carbonates react with acid at room temperature (1) no bubbles would indicate that carbonate is in excess (1) [max 2]

[Total: 6]

10w6

5 (a) (i) blue (1) [1]

(ii) blue (1) precipitate (1) [2]

(iii) blue precipitate (1) deep/royal blue (1) solution (1) or precipitate dissolves [3]

(c) sulfuric acid (2) acid or sulfate only (1) [2]

[Total: 8]
7  (a) universal indicator / pH paper
   pH of 4–6 / yellow / orange (1) not red [2]

   (b) sodium hydroxide / carbonate / oxide [1]

   (c) marks can be obtained from diagram
   chromatography (1) description of applying E110 to paper (1)
   use of solvent (1) results / number of spots (1) [4]

   [Total: 7]

11s6

5  (a) (ii) colourless (1) allow yellow no smell (1) [2]

   (b) (ii) extinguished/white (1) [1]

   (d) yellow (1) precipitate (1) [2]

   (e) organic (1) allow hydrocarbon
   fuel/alcohol/named alcohol (1) allow flammable [2]

11s6

6  (a) diagram of a filter paper in a funnel (1) label funnel/filter paper (1) [2]

   (b) 0.45, 0.95, 1.40, 1.90, 2.35 and 2.35 (2), −1 for each incorrect up to 2 [2]

   (c) all points plotted correctly (2), −1 for each incorrect point up to 2
   two intersecting straight lines (1) ignore origin [3]

   (d) 5 cm$^3$ (1) ignore unit [1]

11w6

2  (a) points plotted correctly (2)
   smooth line graph missing anomalous point (1) [3]

   (b) point at 15 cm$^3$ pH 2.6/third point (1) [1]

   (c) (i) 12.6 (1) [1]

   (ii) pH 1 (1) extrapolation shown (1) [2]

   (d) (i) 7 (1) [1]

   (ii) 25 (1) [1]

   (e) repeat experiment (1) stop when 25 cm$^3$ added/when pH 7 (1)
   evaporate/heat (1) use same volumes (1)
   to crystallising point/until saturated (1) max [3]

11w6
5 (a) (i) P colourless, no smell (1) [1]

(ii) P pH 1–3 (1) [1]

(b) P fizzes/effervescence/bubbles (1) lighted splint pops (1) not hydrogen (2) [2]

(c) white (1) precipitate (1) [2]

(e) weak acid (1) ethanoic acid (2) [2]

(f) water (1) [1]

11w6

2 (a) points plotted correctly (2) smooth line graph missing anomalous point (1) [3]

(b) point at 15 cm³ pH 2.6 third point (1) [1]

(c) (i) 12.6 (1) [1]

(ii) pH 1 (1) extrapolation shown (1) [2]

12s6

1 (a) tripod (1) accept stand spatula (1) not spoon (2) [2]

(b) fizz/bubbles/effervescence stops (1) solid/iron/powder visible / no more iron dissolves/reacts (1) [2]

(c) evaporation of water/steam (1) solid/residue/crystals formed (1) colour change turns brown/darker green (1) effect of heat on solid solid breaks down (1) max 3 [3]

[Total: 7]

12s6

5 (c) fizz/bubbles/effervescence (1) limewater (1) milky/cloudy/white ppt (1) cond. on limewater (3) [3]

(e) ammonia (1) [1]

(f) non-transition metal (1) ammonium (salt or carbonate) (2) not: ammonia max [2]

[Total: 6]
4 (a) Table of results: ignore: units in table
   volume of aqueous potassium chloride boxes completed correctly (1) 1, 2, 4, 5, 6, 7
   heights of solid boxes completed ±1mm (2) 4, 8, 16, 20, 24, 24
   in mm (1) [4]

   (b) all points correctly plotted (2), −1 for any incorrect
   straight line graphs (2) note: one for each line, doesn’t have to go through origin [4]

   (c) value from graph 14 (1) unit (1) shown clearly (1) [3]

   (d) precipitation (1) allow: double decomposition ignore: exo/endothermic [1]

   (e) (i) same (1) no ecf not: almost the same
   all lead nitrate reacted/reaction finished/lead nitrate is limiting factor (1) [2]

   (ii) same heights/owts (1)
   lead nitrate is limiting factor/same amount of lead nitrate/excess potassium chloride (1) [2]

   (g) yellow (precipitate) (1) [1]

   (h) Improvement (1) e.g. use burette/pipette/leave solid to settle longer/repeat
   explanation (1) e.g. instead of a measuring cylinder/heights more accurate/take average [2]

   [Total: 19]

12s6

4 (a) Table of results: ignore: units in table
   volume of aqueous potassium chloride boxes completed correctly (1) 1, 2, 4, 5, 6, 7
   heights of solid boxes completed ±1mm (2) 4, 8, 16, 20, 24, 24
   in mm (1) [4]

   (b) all points correctly plotted (2), −1 for any incorrect
   straight line graphs (2) note: one for each line, doesn’t have to go through origin [4]

   (c) value from graph 14 (1) unit (1) shown clearly (1) [3]

12w6

5 (a) (i) white (1) precipitate (1) dissolves (1) [3]
   (ii) white precipitate (1) dissolves (1) [2]

   (b) no reaction/change (1) [1]

   (c) white (1) precipitate (1) [2]

   (g) chlorine (1) not: chloride [1]

   (h) oxygen (1) [1]

   (i) transition metal present (1) catalyst (1) allow: copper oxide for one mark
   manganese (1) oxide (1) max 2 [2]