CS C1 H Acid reactions and electrolysis

Date:

Time: 47 minutes
Total marks available: 47
Total marks achieved: ______
Questions

Q1.

Acids

(a) Magnesium carbonate reacts with dilute nitric acid.
Give the names of the products formed in this reaction.

(b) Zinc oxide, ZnO, reacts with dilute hydrochloric acid to form zinc chloride, ZnCl₂, and water.

(i) Complete the sentence by putting a cross (X) in the box next to your answer.
This reaction is an example of

- A combustion
- B thermal decomposition
- C neutralisation
- D oxidation

(ii) Write the balanced equation for the reaction between zinc oxide and dilute hydrochloric acid.

* (c) Electrolysis of hydrochloric acid can produce hydrogen and chlorine.
The apparatus for the electrolysis is

- hydrochloric acid
- two carbon rods
- a suitable container for the electrolysis reaction
- a suitable source of electricity
- test tubes

Describe how the apparatus can be used to electrolyse hydrochloric acid and how the gases produced can be tested to show that they are hydrogen and chlorine.
You may use a diagram to help your answer.
Q2.

(i) Complete the sentence by putting a cross (\(\text{\textgreater}\)) in the box next to your answer.

Acids are neutralised by metal hydroxides to form

A salt only
B salt and hydrogen only
C salt and oxygen only
D salt and water only

(ii) Acids can also be neutralised by metal carbonates.

Dilute sulfuric acid is neutralised by copper carbonate as shown in the word equation.

\[
\text{copper carbonate} + \text{sulfuric acid} \rightarrow \text{copper sulfate} + \text{carbon dioxide} + \text{water}
\]

Copper carbonate is a green powder.

Describe what you would see when copper carbonate powder is added to dilute sulfuric acid.

(Total for question = 12 marks)
Q3.

A student carried out an experiment to see how reactive different metals are when they are placed in dilute hydrochloric acid.

A sample of each metal was placed in a separate test tube of acid.

When zinc reacts with dilute hydrochloric acid, a gas is given off and zinc chloride is formed.

(i) Which gas is given off?

- A carbon dioxide
- B chlorine
- C hydrogen
- D oxygen

(ii) What is the formula of zinc chloride?

- A ZnCl
- B ZnCl
- C ZnCl
- D ZnCl

(Total for question = 2 marks)

Q4.

Making sodium chloride

To make pure sodium chloride from sodium hydroxide solution and dilute hydrochloric acid, a titration has to be used.

(a) Ethanol is produced by fermentation of carbohydrates.

The equation for the reaction is

\[ \text{HCl(aq) + NaOH(aq) → NaCl(........) + H}_2\text{O(........)} \]
(a) Which state symbols follow NaCl and H₂O to complete the equation?
Put a cross (X) in the box next to your answer.

<table>
<thead>
<tr>
<th></th>
<th>NaCl</th>
<th>H₂O</th>
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<tbody>
<tr>
<td>A</td>
<td>s</td>
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<td>B</td>
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</tr>
<tr>
<td>D</td>
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</tbody>
</table>

(1)

(b) The reaction above is a neutralisation reaction.
Write the ionic equation for the reaction.

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

(2)

(c) When sodium hydroxide solution is titrated with dilute hydrochloric acid, an acid-base indicator is used.
The hydrochloric acid is added from a burette to the sodium hydroxide solution in a conical flask.
At the end point the indicator changes colour.

(i) Give the name of a suitable indicator to use in this titration.

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

(1)

(ii) State the colour change for this indicator at the end point.

from ...................... to ......................

(1)

(d) A sodium hydroxide solution was made up by dissolving 20.0 g of sodium hydroxide in water and making the volume of the solution up to 1.00 dm³. Calculate the concentration of sodium hydroxide, NaOH, in this solution in mol dm⁻³.

(relative atomic masses: H = 1.00, O = 16.0, Na = 23.0)

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

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

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

concentration = ................................ mol dm⁻³
(e) In another experiment, a titration was carried out. 25.0 cm$^3$ of 1.50 mol dm$^{-3}$ sodium hydroxide solution, NaOH, was titrated with hydrochloric acid. The volume of the hydrochloric acid required to neutralise the sodium hydroxide solution was 30.0 cm$^3$. Calculate the concentration of the hydrochloric acid, HCl, in mol dm$^{-3}$.

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

concentration = ............... mol dm$^{-3}$

(Total for question = 10 marks)

Q5.

(a) A solution contains a mixture of ions with the formulae shown.

\[
\begin{array}{cccc}
\text{Na}^+ & \text{Cl}^- & \text{Mg}^{2+} & \text{SO}_4^{2-}
\end{array}
\]

Give the formulae of all the ions that will be attracted to the negatively charged cathode during electrolysis.

(b) During electrolysis, reduction takes place at the cathode. Explain, in terms of electrons, what is meant by reduction.

(c) Solid lead bromide cannot be electrolysed. Molten lead bromide can be electrolysed. Explain how, when solid lead bromide is melted and electrolysed, bromine is formed at the anode.
*(d) Impure copper can be purified using electrolysis.
The impure copper is used as the anode.
A pure copper cathode is used.
The electrodes are placed in copper sulfate solution.
A direct electric current is passed through the solution.

Describe and explain what is seen when this apparatus is used to purify a piece of impure copper.

(Total for Question = 12 marks)

Q6.

(a) The ions in sodium chloride solution are
sodium ions, Na\(^+\)
chloride ions, Cl\(^-\)
hydrogen ions, H\(^+\)
hydroxide ions, OH\(^-\)
Sodium chloride solution is electrolysed using a direct electric current.
(i) Which of these ions will be attracted to the cathode during the electrolysis of sodium chloride solution?
Put a cross (\(\square\)) in the box next to your answer.

- [ ] A H\(^+\) ions only
- [ ] B H\(^+\) and Na\(^+\) ions
- [ ] C Cl\(^-\) ions only
- [ ] D Cl\(^-\) and OH\(^-\) ions

(ii) Chlorine is one of the products of the electrolysis.
The half-equation for the production of chlorine is
\[ 2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^- \]
Explain how the half-equation shows that chloride ions are oxidised. (2)

(iii) Suggest why the solution remaining at the end of the electrolysis is alkaline. (1)

(iv) The electrolysis of sodium chloride solution does not produce metallic sodium. State what change you would make to the electrolyte to obtain metallic sodium. (1)

(b) (i) When copper sulfate solution is electrolysed using inert electrodes, oxygen is formed at the positively charged anode. Explain how the oxygen is formed from ions in the solution. (2)

(ii) The other product is copper. 1.27 g of copper were produced in an experiment. Calculate the number of moles of copper, Cu, produced in this experiment. (Relative atomic mass: Cu = 63.5) (1)

\[
\text{amount of copper produced} = \text{........................... mol}
\]

(Total for Question = 8 marks)

Examiner's Report

Q1.

(a) Many candidates scored here as they knew that magnesium nitrate was one of the products of the reaction. However a minority of candidates could also state that water and carbon dioxide were also formed. Some incorrectly gave salt instead of magnesium nitrate. More students gave only gave one additional product so failed to gain full credit.

Results Plus: Examiner Comments
A good answer that scored both marks.
**Results Plus: Examiner Comments**

This candidate gave just the generic answer to the question and did not link their knowledge to the question posed.

**Results Plus: Examiner Tip**

Remember to link your knowledge of chemistry to the context given in the question.

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**Results Plus: Examiner Comments**

This response gained one mark for showing an understanding that magnesium nitrate and one other product (carbon dioxide) was produced, full credit was not awarded as they did not state that water was also produced.

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(b)(ii)

Again, students showed a better understanding of how to balance equations than in previous sessions. Many students gained credit for their knowledge of correct formulae of either the product or reactants or both. Many provided a correct balanced equation as a result.

\[
\text{ZnO(s) + 2HCl(aq) \rightarrow ZnCl}_2(s) + H_2O(l)
\]

**Results Plus: Examiner Comments**

An excellent answer which scored full credit, state symbols were not asked for and so were ignored.

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(c)

It was pleasing to see that the majority of candidates were familiar with this practical and had obviously carried it out, or at the very least seen it, as some very good explanations and diagrams were seen. However, many candidates lost marks as they did not fully address the question posed. Some candidates gave a fantastic description of how to set up the equipment including a detailed diagram but then failed to explain how they would test for each of the gases produced. Others gave an excellent description of how to test for the gases, including good detail such as damp blue litmus turning red before bleaching, instead of just stating litmus paper turned white, but then failed to describe how the experiment could be carried out. Some candidates gave incorrect methods for the tests such as using a glowing splint instead of a lit splint to test for hydrogen and some just stated that the squeaky pop test should be used, which did not gain credit.
Electrolysis is the process of breaking down ionic substances into small particles by passing electricity through it using a direct current. To break these substances down, we use two carbon rods and a test tube for each. There should also be a container with water for electrolysis to take place. There are two electrodes, one is positive and the other is negative. When the direct current is on, the hydrochloric acid should be separated. Chlorine is formed on the positive electrode and hydrogen is formed at the negative electrode. The positively charged atoms move to the negative electrode and gain electrons and is reduced. The negatively charged atoms move to the positive electrode and lose electrons so they are oxidised.

Results Plus: Examiner Comments
In this response, the candidate has given a good description of how the apparatus can be used to electrolyse the hydrochloric acid. However, they have not fully addressed the question as they are also asked how the gases produced can be tested, and this has not been covered in the answer.

Results Plus: Examiner Tip
It is important that you address all parts of the question posed. Always re-read the question, followed by your answer to check that your answer is relevant to the question posed and that you have addressed all the appropriate points.
This candidate has given a description of how the apparatus can be used to electrolyse the hydrochloric acid which gains credit. However the tests for hydrogen and chlorine are incorrect so do not gain credit.
Results Plus: Examiner Comments
This candidate gives a good description of how to carry out the experiment. The diagram is useful and helps inform the candidate's answer. The response then goes on to describe the tests, chlorine is described correctly and gains credit. Because of the error in the description of the test (glowing splint) for the hydrogen test, credit could not be gained for this part of the answer...

Q2.

(ii)
This question was generally poorly answered. The majority scored a mark for some mention of...
fizzing/bubbles etc. but responses mentioning the solid disappearing were rare. A few mentioned there would be a colour change but did not state the colour. Some thought it would change from green to black – possibly thinking about heating copper carbonate to form copper oxide. Only a minority of candidates scored two marks and finding an answer containing the correct colour of the final solution was indeed a rarity. Many candidates thought they could name the substances formed as their answer e.g. "Carbon dioxide would be formed".

Describe what you would see when copper carbonate powder is added to dilute sulfuric acid.

Bubbles and the copper carbonate would dissolve (disappear).

Results Plus: Examiner Comments
Marks were obtained for bubbles (1) and the copper carbonate disappearing (1). The majority just made comment about bubbles or fizzes.

(ii) Acids can also be neutralised by metal carbonates.

Dilute sulfuric acid is neutralised by copper carbonate as shown in the word equation.

\[
\text{copper carbonate} + \text{sulfuric acid} \rightarrow \text{copper sulfate} + \text{carbon dioxide} + \text{water}
\]

Copper carbonate is a green powder.

Describe what you would see when copper carbonate powder is added to dilute sulfuric acid.

It would turn from green to blue and it would also fizzle.

Results Plus: Examiner Comments
Marks were given for the correct colour seen - blue (1) and for fizz (1). Only a very small number wrote that a 'blue solution' forms.

Results Plus: Examiner Tip
Questions like this ask for observations that are made. Look at the information that is given in a question. Giving the names of substances that are formed (e.g. carbon dioxide) will not gain credit.
Q3.
No Examiner's Report available for this question

Q4.

(b) This question was very poorly answered. Most candidates struggled with writing the ionic equation for neutralisation. It was apparent that very few candidates knew what is meant by an ionic equation, let alone how to write one.

Many wrote the full symbol equation, and in few cases, word equation. Some candidates were able to score 1 mark for the inclusion of the spectator ions, sodium and chloride ions, on both sides of the equation.

(c) Although there were many correct responses seen by examiners, typically for 'phenolphthalein' or 'methyl orange' coupled with their correct colour changes, many candidates incorrectly suggested indicator paper or 'universal indicator' as a suitable indicator. Centres need to stress to candidates that universal indicator solution is not acceptable for titrations.

Common errors were noted by examiners: extremely poor spelling, particularly for phenolphthalein, such that it was not phonetic and could not score. Occasionally, where a correct indicator had gained credit, the mark for the colour change was not scored, since the change was the incorrect way round or 'clear' was incorrectly used instead of 'colourless' when referring to phenolphthalein.

Results Plus: Examiner Comments
This response mentions 'phenolphthalein' which scored 1 mark for part (i). Unfortunately, the second marking point (pink to colourless) for part (ii) was not awarded, since 'clear' is not equivalent to colourless.
**Results Plus: Examiner Tip**
This is a commonly asked question. It is worthwhile learning key indicators and their correct corresponding colour changes. Remember, universal indicator solution should never be used as an indicator for titration experiments.

The hydrochloric acid is added from a burette to the sodium hydroxide solution in a conical flask. At the end point the indicator changes colour.

(i) Give the name of a suitable indicator to use in this titration.  

**Phenolphthalein**

(ii) State the colour change for this indicator at the end point.  

from **colourless** to **Pink**

**Results Plus: Examiner Comments**
This response scored 1 mark only for correct indicator (and spelled correctly) in part (i), but the colour change is the wrong way round, so the second marking point was not scored.

**(d)**

The majority of candidates correctly calculated the correct concentration for the 2 marks available, or at least 1 mark for correctly calculating the Relative Formula Mass for sodium hydroxide. Commonly seen errors included: dividing the Relative Formula Mass (40 g) by the mass (20 g), namely 40/20, as opposed to the other way round, 20/40. Some calculated the mass concentration, 20 g dm\(^{-3}\), which gained 1 mark only.

**(e)**

Examiners were impressed by the high quality of responses seen, many scoring the full 3 marks available. It was evident that many candidates were able to use the formulae for calculating moles and concentrations competently. Occasionally, candidates inverted arithmetic or lost marks with powers of ten errors, so were limited to 1 or 2 marks. A few answers gained credit for clearly stating that the reactants were in a ratio 1:1.
Results Plus: Examiner Comments
A typical example of a fully correct response, 3 marks. This candidate has used the correct formula triangle and shown all the quantities in a table (correctly calculated the number of moles of sodium hydroxide, and recognised that the reaction is in a 1:1 ratio, and has then calculated the concentration of the hydrochloric acid).

Q5.

(a)
This was well answered on the whole, with most candidates able to correctly identify the two cations, Mg\(^{2+}\) and Na\(^{+}\), for the 1 mark available. Occasionally, candidates simply listed all the ions and consequently did not score.

(b)
The majority of responses did not score any of the 2 marks available, since few candidates were able to recall the definition for reduction, namely 'gain of electrons'. Occasionally, a few
responses gained just 1 mark for 'the cathode gains electrons'.

(b) During electrolysis, reduction takes place at the cathode.

Explain, in terms of electrons, what is meant by reduction.

Reduction is the gain of electrons during a reaction.

Results Plus: Examiner Comments
A good example of a correct, albeit rarely seen, response. This was awarded the 2 marks available.

A reduction is when it loses an electron.

As an example, sodium has (\[\text{\(\text{Na}^+\)}\]) an extra one on its last shell. So it loses it to make itself stable.

Results Plus: Examiner Comments
Oxidation has been confused with reduction - a typical error. This was awarded 0 marks.

Reduction is loss of oxygen and the gain of electrons.

(c)

This question was badly answered. Very few correct responses gaining 3 marks were seen. Most responses were able to score just 1 mark, by reference to the third marking point, namely by reference to the idea that bromide ions are attracted to the anode. Occasionally, responses referred to the second marking point, namely to movement of ions in molten liquid. It was evident that few candidates could recall, let alone explain, the electrolysis of molten lead bromide, or recognise that molten ionic substances can conduct electricity.
(c) Solid lead bromide cannot be electrolysed. Molten lead bromide can be electrolysed.

Explain how, when solid lead bromide is melted and electrolysed, bromine is formed at the anode.

...as it is melted its particles are free to move. Therefore the negative ions go to the anode. This then allows bromine to form at the anode.

Results Plus: Examiner Comments
A typical 2 marks response when seen, awarded 2 out of the 3 marks available. Marking points 2 and 3 have been awarded.

(c) Solid lead bromide cannot be electrolysed. Molten lead bromide can be electrolysed.

Explain how, when solid lead bromide is melted and electrolysed, bromine is formed at the anode.

...bromine is a negatively charged therefore it would migrate towards the positively charged anode, and loses all other properties towards the positively charged cathode.

Results Plus: Examiner Comments
A typical 1 mark response awarded for marking point 3 only. There is no specific mention of particles moving in the molten liquid, so marking point 2 was not scored.

(c) Solid lead bromide cannot be electrolysed. Molten lead bromide can be electrolysed.

Explain how, when solid lead bromide is melted and electrolysed, bromine is formed at the anode.

...when solid lead bromide is melted, the ions are free to move so it can be electrolysed. The lead is attracted to positive cathode and bromine is attracted to the opposite electrode which is anode.

Results Plus: Examiner Comments
A typical 1 mark answer awarded for marking point 2 only, namely for the recognition that ions are free to move in the molten lead bromide. The final incorrect sentence can be ignored.
(c) Solid lead bromide cannot be electrolysed. Molten lead bromide can be electrolysed.

Explain how, when solid lead bromide is melted and electrolysed, bromine is formed at the anode.

When the lead bromide is electrolysed, the negatively charged particles move towards the anode as it is positively charged whereas the positively charged lead particles move towards the cathode. Therefore bromine is collected at the anode. This is not possible with solid lead bromide as the particles are not free to move.

Results Plus: Examiner Comments
A very rarely seen fully correct response. Marking points 1, 2 and 3 have been mentioned, so 3 marks have been awarded.

(d)

This was a poorly answered question overall. Most candidates failed to give any creditworthy points. Of the correct responses seen, most gained just 2 marks, Level 1, often by a simple description of the deposition of copper at the cathode and a decrease in size of the anode. Few candidates could add further description for Level 2, let alone explain the redox processes, necessary for Level 3.
(d) Impure copper can be purified using electrolysis.

The impure copper is used as the anode.
A pure copper cathode is used.
The electrodes are placed in copper sulfate solution.
A direct electric current is passed through the solution.

Describe and explain what is seen when this apparatus is used to purify a piece of impure copper.

The copper ions from the impure copper anode are released into the copper sulfate solution. The impurities deposit and form sludge at the bottom of the beaker. The pure copper ions attract to the cathode as the pure copper ions are positively charged. The impure copper anode will decrease in mass as oxidation (loss of electrons) occurs and the cathode of pure copper will increase in mass as reduction occurs (gain of electrons). This will leave a pure copper cathode.

Results Plus: Examiner Comments
A typical good quality Level 3 answer. There is a detailed description (3 clear points) and an explanation (3 clear points). This was awarded 6 marks.
*(d) Impure copper can be purified using electrolysis.

The impure copper is used as the anode.
A pure copper cathode is used.
The electrodes are placed in copper sulfate solution.
A direct electric current is passed through the solution.

Describe and explain what is seen when this apparatus is used to purify a piece of impure copper.

Positively

Copper is negatively charged so it is attracted to the negatively charged cathode. At the cathode a copper coating begins to form, the size of the cathode increases throughout the purification. At the anode, since copper atoms are being lost, the size of the anode decreases and impurities form below the anode. Sulfur gas is given off also at the anode since it has sulfur in negatively charged. The at the beginning of the electrolysis the solution was blue but at the end the blue fades

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**Results Plus: Examiner Comments**

A typical Level 2 response. There is sufficient description of processes occurring at the cathode and anode and of the impurities, so this was awarded 4 marks. There is insufficient explanation to award Level 3.
Q6.  

(a) (ii)  

Many candidates knew that oxidation is loss of electrons. Some candidates were confused between chloride ions and chlorine and it was not unusual to see that some candidates read the half-equation in reverse and they wrote about chlorine gaining electrons. Some candidates wrote that the chloride ions lost their negative charge but this did not score any marks as they needed to refer to electron loss.
(ii) Chlorine is one of the products of the electrolysis.
The half-equation for the production of chlorine is
\[ 2Cl^- \rightarrow Cl_2 + 2e^- \]
Explain how the half-equation shows that chloride ions are oxidised.

This shows that the chloride ions are oxidised because the chlorine is neutral.

Results Plus: Examiner Comments
This answer did not score any marks as there was no mention of electrons.

Results Plus: Examiner Tip
Use OIL RIG to help you to remember about oxidation and reduction.
Oxidation is Loss of electrons.
Reduction is Gain of electrons.

(a) (iii)
A large number of candidates were able to work out that sodium hydroxide solution was left. However, some candidates thought that sodium was left and as it is an alkali metal, the solution would be alkaline. A few candidates thought the solution would be alkaline as acidic chlorine is lost.

Results Plus: Examiner Comments
This is a very good answer, scoring 2 marks.

(iii) Suggest why the solution remaining at the end of the electrolysis is alkaline.

Sodium chloride solution is neutral, so this answer did not score a mark.
Remember that acids contain H+ ions and alkalis contain OH- ions.

Results Plus: Examiner Comments
This is a very good answer and scored 1 mark.

(a) (iv)
Surprisingly few candidates knew that molten sodium chloride is used to produce sodium. Quite a large number did not read the question carefully and they suggested changing an electrode to sodium rather than changing the electrolyte, or increasing the voltage.

Results Plus: Examiner Comments
This candidate has suggested a change to the electrodes so has not scored a mark. The question asks for a change to the electrolyte.

Results Plus: Examiner Tip
Read the question carefully.

Results Plus: Examiner Comments
This is a good answer, scoring 1 mark.

(b) (i)
This question was not answered well by many candidates. A lot of candidates thought that there
were oxide ions in water or that the oxygen was produced from the sulfate ions. Candidates should be made aware that the ions from water can be discharged at the electrodes during electrolysis of a solution. Some candidates showed an excellent understanding of what was happening and they gave a balanced half-equation for the reaction at the anode.

Results Plus: Examiner Comments
This candidate did not score any marks.

Results Plus: Examiner Tip
Ions react at the electrodes by gaining or losing electrons.

Results Plus: Examiner Comments
This candidate thought that there were oxide ions in the solution. However, they do know that the oxygen was formed by loss of electrons at the anode, so scored 1 mark.

Results Plus: Examiner Tip
Remember that water contains a few hydrogen ions, H+, and a few hydroxide ions, OH-. During electrolysis, these ions can gain or lose electrons to form hydrogen gas or oxygen gas.
(b) (i) When copper sulfate solution is electrolysed using inert electrodes, oxygen is formed at the positively charged anode.

Explain how the oxygen is formed from ions in the solution.

The hydroxide ions in the solution lose electrons (lose charge) more readily than sulfate ions in the solution, so when the hydroxide is discharged at the cathode, water and oxygen is formed.

Results Plus: Examiner Comments
This is a very good answer that identifies the hydroxide ions in the solution and states that they lose electrons to form oxygen. This answer scored both marks.

(b) (ii)

This question was answered correctly by a large number of candidates. Just small numbers of candidates multiplied the mass by the relative atomic mass or divided the relative atomic mass by the mass of copper.

(ii) The other product is copper.

1.27 g of copper were produced in an experiment.

Calculate the number of moles of copper, Cu, produced in this experiment.

(Relative atomic mass: Cu = 63.5)

\[ \frac{1.27}{63.5} = 0.02 \]

amount of copper produced = 0.02 mol

(Total for Question 1 = 8 marks)

Results Plus: Examiner Comments
This correct answer scored 1 mark.
(ii) The other product is copper.

1.27 g of copper were produced in an experiment.

Calculate the number of moles of copper, Cu, produced in this experiment.
(Relative atomic mass: Cu = 63.5)

\[
\frac{12.7}{63.5} = \frac{1}{5} = 0.2
\]

(amount of copper produced = 0.2 mol)

(Total for Question 1 = 8 marks)

\[
\frac{12.7}{63.5} = \frac{5}{5} = 0.2
\]

Results Plus: Examiner Comments
This candidate has mis-read the question. The mass of copper is 1.27 g not 12.7 g.

Results Plus: Examiner Tip
Avoid making careless errors. Read the question carefully.

Mark Scheme

Q1.
<table>
<thead>
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<th>Question Number</th>
<th>Answer</th>
<th>Acceptable answers</th>
<th>Mark</th>
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<tbody>
<tr>
<td>(a)</td>
<td>magnesium nitrate water carbon dioxide all three correct (2) magnesium nitrate + one other correct (1)</td>
<td>allow correct formulae</td>
<td>(2)</td>
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<tr>
<td>(b)(i)</td>
<td>C – neutralisation</td>
<td></td>
<td>(1)</td>
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<td>(b)(ii)</td>
<td>$\text{ZnO} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2\text{O}$ (3) LHS (1) RHS (1) balancing of correct formula (1)</td>
<td>correct multiples ignore state symbols</td>
<td>(3)</td>
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<td><strong>QWC</strong></td>
<td>A description including some of the following points</td>
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<td>experiment set up</td>
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<td>• hydrochloric acid in container</td>
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<td>• attach rods to electrical supply</td>
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<td>• d.c. supply (or reference to positive and negative)</td>
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<td>• test tubes to collect gases</td>
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<td>• squeaky pop (with air)/burns</td>
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<td>• (damp blue) litmus paper</td>
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<td>• (turns red then) bleaches/white</td>
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<tr>
<td><strong>1</strong></td>
<td>1 – 2</td>
<td>a limited description e.g. simple description/diagram of electrolysis set up OR description of test for one of the gases.</td>
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<tr>
<td></td>
<td></td>
<td>the answer communicates ideas using simple language and uses limited scientific terminology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spelling, punctuation and grammar are used with limited accuracy</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>3 – 4</td>
<td>a simple description e.g. a full description of electrolysis OR test for both gases OR simple description of electrolysis and the test for one of the gases.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spelling, punctuation and grammar are used with some accuracy</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>5 – 6</td>
<td>a detailed description e.g. description of electrolysis and test for both gases OR a full description of electrolysis and of one gas test.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The answer communicates ideas clearly and coherently uses a range of scientific terminology accurately</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spelling, punctuation and grammar are used with few errors</td>
</tr>
</tbody>
</table>

Q2.
### Q3.

<table>
<thead>
<tr>
<th>Question number</th>
<th>Answer</th>
<th>Acceptable answers</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>D</td>
<td>salt and water only</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question number</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ii)</td>
<td>A description to include two from</td>
</tr>
<tr>
<td></td>
<td>• (green) solid {disappears / dissolves} (1)</td>
</tr>
<tr>
<td></td>
<td>• effervesces / bubbles (of colourless gas) given off (1)</td>
</tr>
<tr>
<td></td>
<td>• blue (solution) forms (1)</td>
</tr>
</tbody>
</table>

**Acceptable answers**
- Ignore references to names of products
- Fizz
- Goes blue
- Ignore incorrect colours of solution
- Ignore temperature rise

### Q4.
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Answer</th>
<th>Acceptable answers</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>D aq l</td>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>(b)</td>
<td>$H^+ + OH^- \rightarrow H_2O$ (1)</td>
<td>LHS (1) RHS (1) ignore state symbols, even if incorrect. Allow inclusion of spectator ions, Na$^+$ and Cl$^-$, if shown on both sides for one mark max.</td>
<td>(2)</td>
</tr>
<tr>
<td>(c)(i)</td>
<td>suitable acid-base indicator eg methyl orange, phenolphthalein</td>
<td>Litmus reject universal indicator allow recognisable phonetic spelling</td>
<td>(1)</td>
</tr>
</tbody>
</table>
| (c)(ii)         | correct colour change for suitable indicator in 4(c)(i):
methyl orange: yellow → orange/pink/red
phenolphthalein: magenta/pink → colourless | Litmus: blue → red ignore clear | (1)  |
| (d)             | rel mass NaOH = 23.0 + 16.0 + 1.00 (1)
concentration = $\frac{20.0 \times 1}{1}$ (1) formula mass | ($= 40.0$) (1)
$0.5 \text{ (mol dm}^{-3}\text{)}$ without working | (2)  |
Q5.

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Answer</th>
<th>Acceptable answers</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e)</td>
<td>moles of NaOH = (25.0 \times 1.50 \div 1000) (= 0.0375 \text{ moles})</td>
<td>0.0375 (1) – without working shown</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ratio 1 : 1 / moles NaOH = moles HCl (1)</td>
<td>conc of HCl = (0.0375 \times 1000 \div 30.0) (= 1.25 \text{ (mol dm}^{-3}))</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OR (25.0 \times 1.50 = 30.0 \times \text{conc acid}) (2)</td>
<td>conc of HCl = (25.0 \times 1.50 \div 30.0) (=1.25 \text{ (mol dm}^{-3}))</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>conc of HCl = (25.0 \times 1.50 \div 30.0) (1)</td>
<td>allow (0.00125 / 0.125 / 12.5 \text{ max})</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Answer</th>
<th>Acceptable answers</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Na\textsuperscript{+} and Mg\textsuperscript{2+}</td>
<td>reject if any other ions are given allow names</td>
<td>(1)</td>
</tr>
<tr>
<td>(b)</td>
<td>An explanation linking (reduction is) gain of electrons(2)</td>
<td>if cathode gains electrons – 1 mark; loss of oxygen – 1 mark</td>
<td>(2)</td>
</tr>
<tr>
<td>(c)</td>
<td>An explanation linking three of the following ions / particles cannot move in solid (1) ions / particles move in molten liquid / lattice structure is broken on melting (1) bromide (ions) / negatively charged (ions /bromine) move / attracted to anode (1) bromide (ions) lose electrons / (bromide ions) are oxidised(1) to form bromine atoms (1) bromine molecules / (\text{Br}_2) formed (1)</td>
<td>Half equation, even unbalanced, showing bromide ions losing electrons (2)</td>
<td>(3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Indicative Content</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>QWC * (d)</td>
<td>A description / explanation including some of the following</td>
<td>(6)</td>
</tr>
<tr>
<td>Level</td>
<td>Score</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>No rewardable content</td>
</tr>
<tr>
<td>1</td>
<td>1 - 2</td>
<td>a limited description e.g. copper leaves the anode and deposits on the cathode. The answer communicates ideas using simple language and uses limited scientific terminology. Spelling, punctuation and grammar are used with limited accuracy.</td>
</tr>
<tr>
<td>2</td>
<td>3 - 4</td>
<td>a simple description e.g. copper leaves the anode and deposits on the cathode and impurities fall to the bottom of the beaker. The answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately. Spelling, punctuation and grammar are</td>
</tr>
</tbody>
</table>
Q6.

<table>
<thead>
<tr>
<th></th>
<th>Answer</th>
<th>Acceptable answers</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)(i)</td>
<td>B $\text{H}^+$ and Na$^+$ ions</td>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>(a)(ii)</td>
<td>An explanation linking</td>
<td>ignore reference to number of electrons do not allow negative charge chlorine gains electrons (0) allow chlorine loses electrons (1)</td>
<td>(2)</td>
</tr>
<tr>
<td>(a)(iii)</td>
<td>Any one from</td>
<td>ignore solution has pH greater than 7 allow no hydrogen ions left/acidic ions removed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>it contains (excess) hydroxide/OH$^-$ ions (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sodium/Na$^+$ ions and hydroxide/OH$^-$ ions remain (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>it is sodium hydroxide/NaOH (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>hydrogen/H$^+$ ions have been removed (at the cathode) (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)(iv)</td>
<td>use molten/liquid sodium chloride/electrolyte / melt it/sodium chloride/electrolyte</td>
<td>ignore just liquid/liquid sodium</td>
<td>(1)</td>
</tr>
<tr>
<td>(b)(i)</td>
<td>An explanation linking: Marking point 1</td>
<td>half equation, even unbalanced, showing hydroxide ions losing electrons (2) do not allow marking point 1 if only oxygen/sulfate ions mentioned</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>hydroxide/OH$^-$ ions (from water) (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b)(ii)</td>
<td>$1.27 / 63.5$ (1) (= 0.02)</td>
<td>0.02 with no working (1) correct working with incorrect answer (1)</td>
<td>(1)</td>
</tr>
</tbody>
</table>