Name: ____________________

Chemical Changes part 1 AQA Triple Chemistry

Class: ____________________

Date: ____________________

Time: **76 minutes**

Marks: **71 marks**

Comments:

1. Zinc reacts with iodine to produce the salt zinc iodide.

The reaction is done in a solution using ethanol as the solvent.

Ethanol is a flammable liquid with a boiling point of 78 °C.

The table below shows the solubility of zinc, iodine and zinc iodide in ethanol.

	Zinc	**Iodine**	**Zinc iodide**
Solubility in ethanol	Insoluble	Soluble	Soluble

(a) Plan a method to obtain crystals of zinc iodide from zinc and iodine.

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(6)

(b) A student used 6.35 g of iodine in the reaction.

6.29 g of zinc iodide was produced.

The equation for the reaction is:

$$Zn + I_2 \rightarrow ZnI_2$$

Calculate the percentage yield of zinc iodide.

Give your answer to 3 significant figures.

Relative formula masses (M_r): I_2 = 254 ZnI_2 = 319

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____

____

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____

____

Percentage yield (3 significant figures) = ____________________ %

(5)

(Total 11 marks)

2. This question is about energy changes of reactions.

Zinc reacts with copper sulfate solution.

The word equation for the reaction is:

zinc + copper sulfate → zinc sulfate + copper

(a) What type of reaction is the reaction between zinc and copper sulfate solution?

Tick (✓) **one** box.

Combustion	☐
Decomposition	☐
Displacement	☐

(1)

(b) Calculate the percentage (%) by mass of copper in copper sulfate (CuSO4).

Give your answer to 3 significant figures.

Relative atomic mass (*A*r): Cu = 63.5

Relative formula mass (*M*r): $CuSO_4$ = 159.5

____

____

____

____

____

Percentage by mass (3 significant figures) = ________ %

(3)

A student investigated the energy change in the reaction between zinc and copper sulfate solution.

This is the method used.

1. Measure 25 cm^3 of copper sulfate solution into a polystyrene cup.

2. Weigh 0.20 g of zinc powder.

3. Add the zinc powder to the copper sulfate solution.

4. Measure the highest temperature reached by the mixture.

5. Repeat steps 1 to 4 using different masses of zinc powder.

(c) Control variables are used to make an investigation a fair test.

Which is a control variable in the investigation?

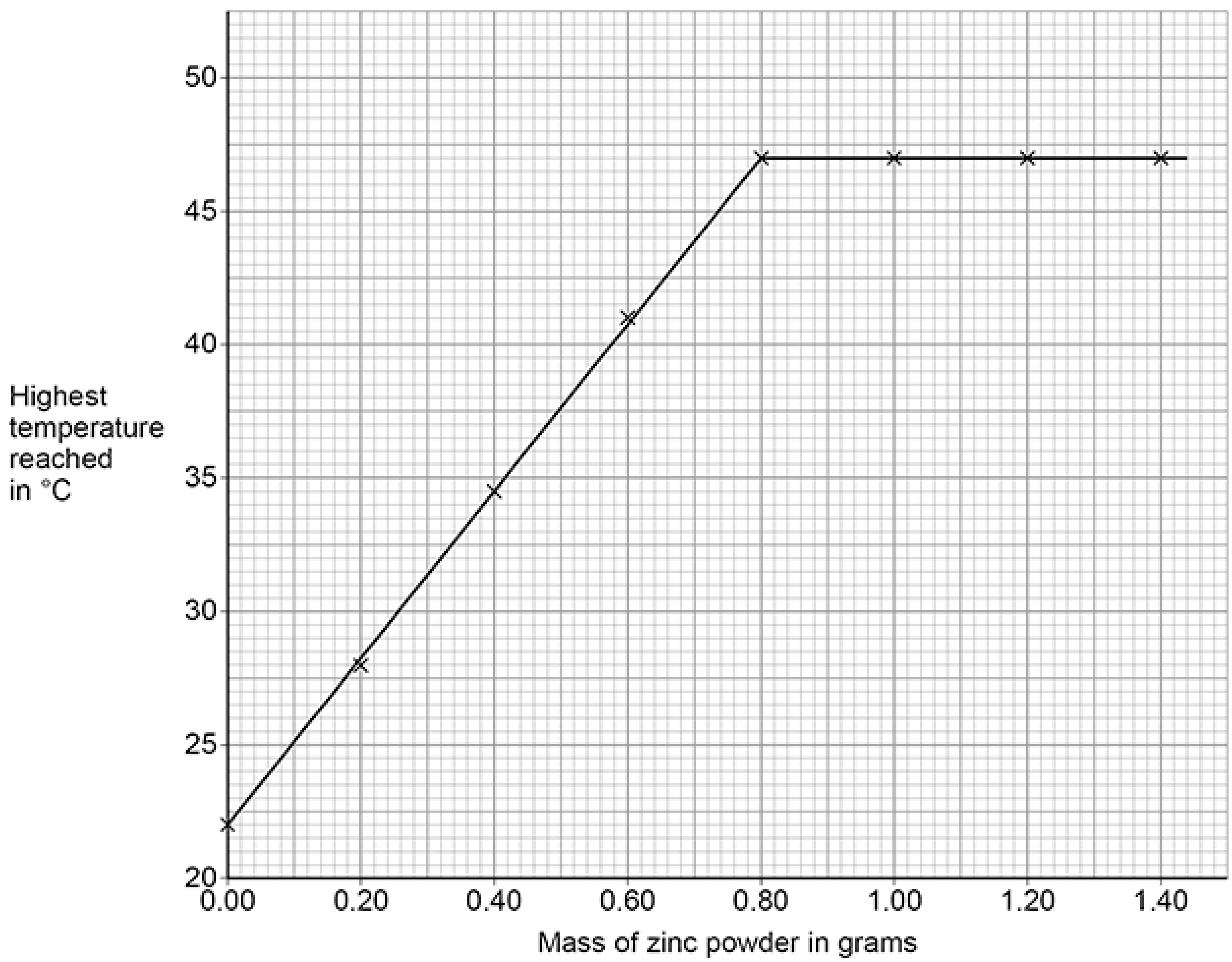
Tick (✓) **one** box.

Highest temperature reached by the mixture	☐
Mass of zinc powder	☐
Volume of copper sulfate solution	☐

(1)

Figure 1 shows the results.

Figure 1



(d) What is the minimum mass of zinc powder needed to react with all the copper sulfate solution?

Use **Figure 1**.

Minimum mass of zinc powder = ___________ g

(1)

(e) What is the maximum temperature change in the reaction between zinc powder and 25 cm^3 of copper sulfate solution?

Use **Figure 1**.

____

____

____

Maximum temperature change = ___________ °C

(2)

(f) 25 cm^3 of copper sulfate solution contained 6.75 g of copper sulfate.

Calculate the concentration of the solution in g/dm^3.

You should:

- calculate the volume of the solution in dm^3 (1000 cm^3 = 1 dm^3)
- use the equation:

$$\text{concentration of solution in g/dm}^3 = \frac{\text{mass of copper sulfate in grams}}{\text{volume of solution in dm}^3}$$

____

____

Volume of solution = ___________ dm^3

____

____

____

Concentration of solution = ___________ g/dm^3

(3)

Another student investigated the energy change of the reaction between sodium hydrogencarbonate and hydrochloric acid.

This is the method used.

1. Measure 25 cm^3 of hydrochloric acid.

2. Weigh 1.0 g of sodium hydrogencarbonate.

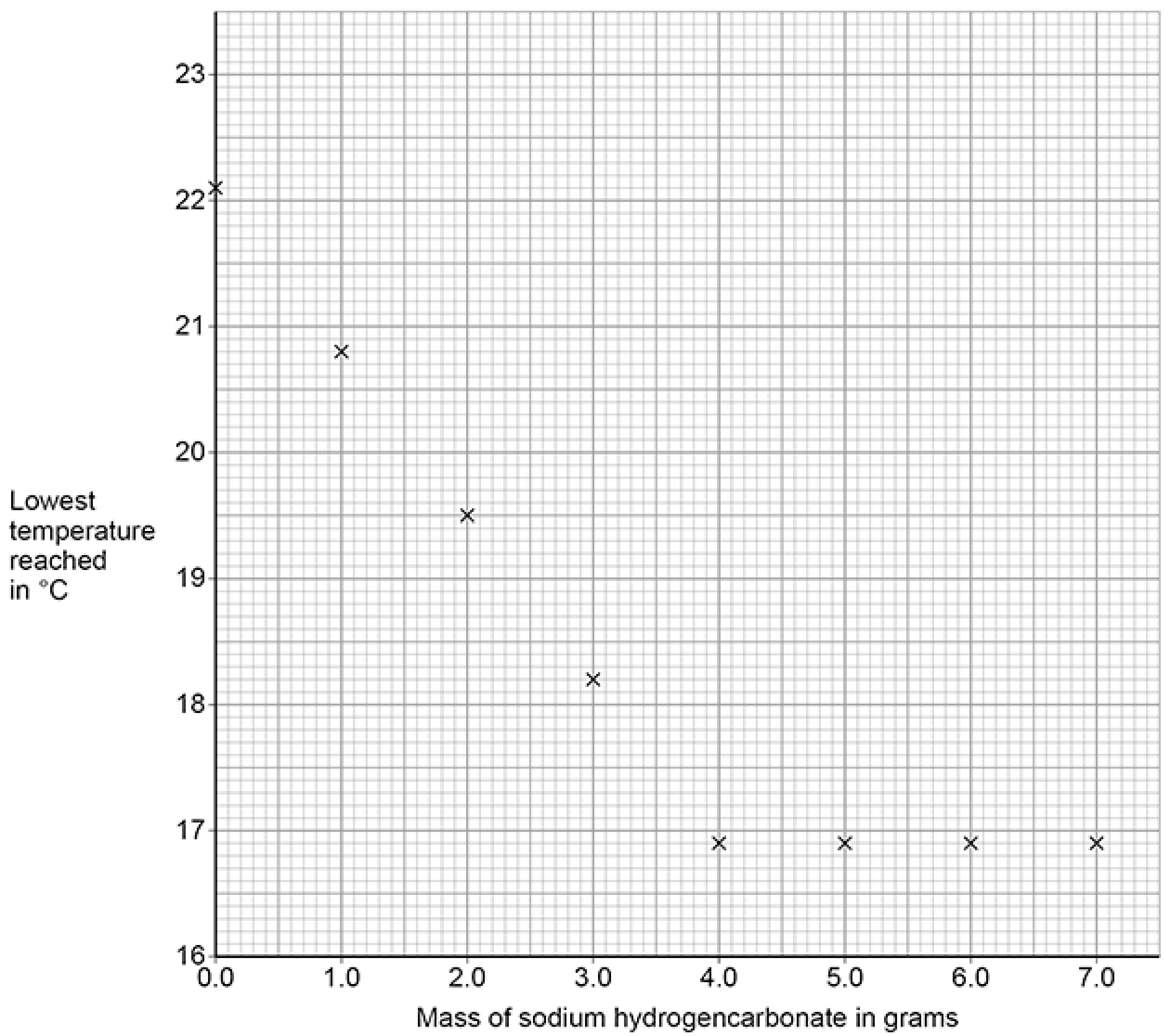
3. Add the sample of sodium hydrogencarbonate to the hydrochloric acid.

4. Measure the lowest temperature reached by the mixture.

5. Repeat steps 1 to 4 using different masses of sodium hydrogencarbonate.

Figure 2 shows the results.

Figure 2



(g) Draw **two** straight lines of best fit on **Figure 2**.

The lines should cross.

(2)

(h) Which statement describes the energy change in the reaction shown in **Figure 2**?

Tick (✓) **one** box.

Energy is **transferred to** the surroundings so the reaction is **endothermic**.	☐
Energy is **transferred to** the surroundings so the reaction is **exothermic**.	☐
Energy is **taken in from** the surroundings so the reaction is **endothermic**.	☐
Energy is **taken in from** the surroundings so the reaction is **exothermic**.	☐

(1)
(Total 14 marks)

3. This question is about electrolysis and the extraction of metals.

(a) Why can some molten substances be electrolysed?

Tick (✓) **one** box.

Electrons can move through the molten substance to the electrodes.	☐
Ions can move through the molten substance to the electrodes.	☐
Protons can move through the molten substance to the electrodes.	☐

(1)

(b) The table below shows the products of the electrolysis of some molten compounds.

Complete below table.

Molten compound	**Product at negative electrode**	**Product at positive electrode**
Lead chloride	________________	Chlorine
Potassium iodide	Potassium	________________
________________	Zinc	Bromine

(3)

Aluminium is extracted by electrolysing molten aluminium oxide.

(c) Balance the equation for the reaction.

Choose numbers from the box.

2	**3**	**4**	**5**

$$2\ Al_2O_3 \rightarrow \_\_\_ Al + \_\_\_ O_2$$

(2)

(d) Calculate the relative formula mass (M_r) of aluminium oxide (Al_2O_3).

Relative atomic masses (A_r): O = 16 Al = 27

____

____

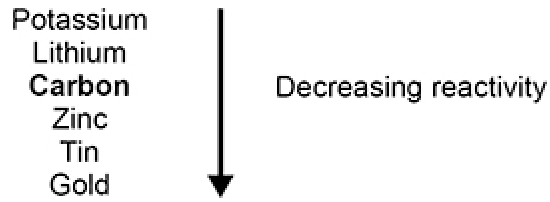
____

Relative formula mass (M_r) = ___________

(2)

(e) The figure below shows part of the reactivity series of metals.

The non-metal carbon has been included.



Metals can be extracted from their compounds by:

- electrolysis
- reduction with carbon.

Electrolysis is more expensive than reduction with carbon.

Predict one metal that would be extracted by each method.

Use the figure above.

Extracted by electrolysis ____________________

Extracted by carbon reduction ____________________

(2)

(Total 10 marks)

4. This question is about chemical cells.

(a) A student connects four 1.5 V cells in series to make a battery.

What is the total voltage produced by the battery?

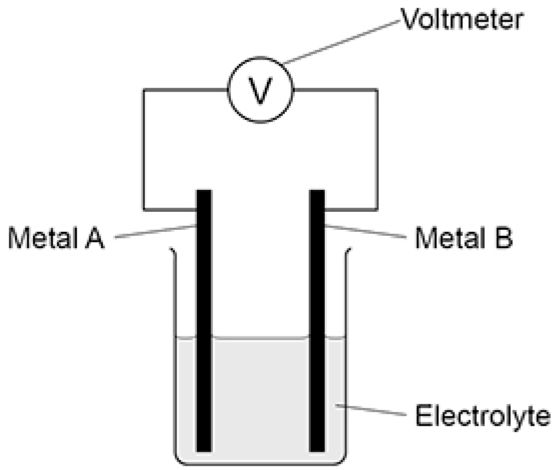
____

Voltage = __________ V

(1)

A chemical cell can be made using two different metals in contact with an electrolyte.

The figure below shows a chemical cell.



(b) Which is a suitable electrolyte for a chemical cell?

Tick (✓) **one** box.

Pure water ☐

Solid lead bromide ☐

Sodium chloride solution ☐

(1)

(c) A student made the hypothesis:

'The voltage produced by a cell depends on the difference in the reactivity of metal **A** and metal **B**.'

Plan an investigation to test this hypothesis.

Your plan should produce valid results.

Use the above figure.

(6)
(Total 8 marks)

5. A student produced a salt by reacting copper carbonate with sulfuric acid.

This is the method used.

1. Measure 50 cm^3 of sulfuric acid into a beaker.
2. Add copper carbonate powder.
3. Stir the mixture.
4. Repeat steps 2 and 3 until copper carbonate is in excess.
5. Filter the mixture.
6. Warm the filtrate gently until crystals start to appear.
7. Leave the solution to cool and crystallise.

(a) Complete the word equation for the reaction.

copper carbonate + sulfuric acid → ______________ + ______________ + carbon dioxide

(2)

(b) Give **one** observation the student could make during **Step 4** which shows that the copper carbonate is in excess.

____

____

(1)

(c) Give **one** reason for filtering the mixture in **Step 5**.

____

____

(1)

(d) Name the equipment that can be used to warm the filtrate **gently** in **Step 6**.

____

____

(1)

(e) The maximum theoretical mass of the salt that could be produced using 50 cm^3 of the sulfuric acid is 12.5 g.

The percentage yield of the salt is 92.8%.

Calculate the mass of salt actually produced.

Use the equation:

$$\% \text{ yield} = \frac{\text{mass of salt actually produced}}{\text{maximum theoretical mass of salt that could be produced}} \times 100$$

___

___

___

___

___

Mass of salt actually produced = ___________ g

(3)

(f) Some salts can be produced by reacting sulfuric acid with a metal.

Neither copper nor sodium is used to produce a salt with sulfuric acid.

Give **one** reason why each metal is **not** used.

Copper ___

___

Sodium ___

___

(2)

(Total 10 marks)

6. This question is about acids and alkalis.

(a) Acids and alkalis are substances that produce ions in aqueous solution.

Draw **one** line from each substance to the ion always produced by that substance in aqueous solution.

Substance	**Ion always produced in aqueous solution**
	Cl^-
Acid	H^+
	Na^+
Alkali	OH^-
	SO_4^{2-}

(2)

(b) What type of aqueous solution has a pH of 11?

Tick (✓) **one** box.

Acidic ☐

Alkaline ☐

Neutral ☐

(1)

A student determined the reacting volumes of hydrochloric acid and sodium hydroxide solution by titration.

This is the method used.

1. Measure 25.0 cm^3 of the sodium hydroxide solution.

2. Add the sodium hydroxide solution to a conical flask.

3. Add 3 drops of indicator to the sodium hydroxide solution.

4. Add the hydrochloric acid drop by drop until the indicator changes colour.

5. Record the volume of the hydrochloric acid added.

6. Repeat steps 1 to 5 three more times.

(c) Which piece of equipment should be used to measure 25.0 cm^3 of the sodium hydroxide solution in step 1?

Tick (✓) **one** box.

Beaker ☐

Pipette ☐

Ruler ☐

(1)

(d) Which piece of equipment should be used to add the hydrochloric acid drop by drop in step 4?

Tick (✓) **one** box.

Balance ☐

Burette ☐

Measuring cylinder ☐

(1)

The table below shows the results.

Trial	**1**	**2**	**3**	**4**
Volume of hydrochloric acid added in cm^3	24.3	24.5	28.1	24.4

(e) Which is the anomalous result in the table above?

Trial 1 ☐ Trial 2 ☐ Trial 3 ☐ Trial 4 ☐

(1)

(f) Suggest **one** reason for the anomalous result in the table above.

____

____

(1)

(g) The student used a solution of sodium hydroxide of concentration 4.00 g/dm^3.

Calculate the mass of sodium hydroxide in 25.0 cm^3 of this solution.

1 dm^3 = 1000 cm^3

____

____

____

____

____

Mass = ___________ g

(3)

(Total 10 marks)

7. This question is about making a soluble salt.

(a) Plan a method to make pure, dry crystals of zinc chloride from zinc carbonate and a dilute acid.

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____

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____

____

____

(6)

(b) Name **two** other substances that can each be reacted with a dilute acid to make zinc chloride.

Do **not** refer to zinc carbonate in your answer.

1 ____

2 ____

(2)

(Total 8 marks)

Mark schemes

1. (a) **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

5-6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3-4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1-2

No relevant content

0

Indicative content

dissolve iodine in ethanol
- in a beaker

add zinc to iodine solution
- stir

continue adding until zinc is in excess
- shown by solid remaining

filter (the reaction mixture)
- to remove the excess zinc

heat the solution
- using a water bath
  or
  using an electric heater
- to evaporate off some of the ethanol
- cool / leave remaining solution to crystallise

(b)

$\left(\text{moles } I_2 = \frac{6.35}{254} =\right) 0.025$

1

(moles ZnI_2 = 0.025 theoretical mass ZnI_2 = 0.025 × 319 =)
7.975 (g)

allow (moles Zn = 0.025 mass of Zn = 0.025 × 65 = 1.625 g theoretical mass ZnI_2 = 1.625 + 6.35 =) 7.975 (g)

allow correct use of an incorrectly determined number of moles of I_2

1

(% yield =) $\frac{6.29}{7.975} \times 100$

allow correct use of an incorrectly determined theoretical mass of ZnI_2

1

= 78.871 (%)

1

= 78.9 (%)

allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses both mass values in the question

alternative approach 1:

$\left(\text{moles } I_2 = \frac{6.35}{254} =\right) 0.025$ (1)

$\left(\text{moles } ZnI_2 = \frac{6.29}{319} =\right) 0.019717868$ (1)

(% yield =) $\frac{0.019717868}{0.025} \times 100$ (1)

allow correct use of an incorrectly determined number of moles of I_2 and/or ZnI_2

= 78.871 (%) (1)

= 78.9 (%) (1)

allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses both mass values in the question

alternative approach 2:

$\left(\text{moles } ZnI_2 = \frac{6.29}{319} =\right)$ 0.019717868 (1)

(moles I_2 reacted = 0.019717868
mass I_2 reacted = 0.019717868 × 254 =)
5.0083(g) (1)

(% yield =) $\frac{5.0083}{6.35} \times 100$ (1)

allow correct use of an incorrectly determined number of moles of ZnI_2

= 78.871 (%) (1)

= 78.9 (%) (1)

allow correct use of an incorrectly determined mass of I_2 reacted
allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses both mass values in the question

1

[11]

2. (a) displacement

1

(b)

(percentage =) $\frac{63.5}{159.5} \times 100$

1

= 39.81191 (%)

1

= 39.8 %

allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses both the values in the question

1

(c) volume of copper sulfate solution

1

(d) 0.8(0) g

1

(e) (maximum temperature change) = 47 – 22 (ºC)

1

= 25 (ºC)

allow correct use of incorrectly determined value(s) from the graph

1

(f) (conversion 25 cm^3 =) 0.025 dm^3 1

(concentration =) $\frac{6.75}{0.025}$ (g/dm^3)

allow correct use of an incorrectly determined or unconverted volume 1

= 270 (g/dm^3) 1

(g) line of best fit using the first five points

*max **1** mark if the lines do not intersect* 1

line of best fit using the last four points 1

(h) energy is **taken in from** the surroundings so the reaction is **endothermic** 1

[14]

3. (a) ions can move through the molten substance to the electrodes 1

(b)

Molten compound	**Product at negative electrode**	**Product at positive electrode**
Lead chloride	**Lead**	Chlorine
Potassium iodide	Potassium	**Iodine**
Zinc bromide	Zinc	Bromine

1
1
1

(c) $2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$

*allow **1** mark for 4 Al*

*allow **1** mark for 3 O_2* 2

(d) (M_r =)
(27 × 2) + (16 × 3) 1

= 102 1

(e) (by electrolysis) any **one** from:

- potassium / K
- lithium / Li

allow aluminium / Al

allow sodium / Na

allow calcium / Ca

allow magnesium / Mg

1

(by carbon reduction) any **one** from:

- zinc / Zn
- tin / Sn

allow iron / Fe

allow copper / Cu

1

[10]

4. (a) 6 (V)

1

(b) sodium chloride solution

1

(c) **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

5−6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3−4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1−2

No relevant content

0

Indicative content

- set up a cell
- **add an electrolyte**
- into a beaker
- **add two (different) metals**

- **measure the voltage**
- using a voltmeter

- **repeat using different metals**

- same volume of electrolyte
- same concentration of electrolyte
- same type of electrolyte

- one metal kept the same each time

[8]

5. (a) copper sulfate

allow $CuSO_4$

1

water

allow H_2O

1

(b) solid remains (in the mixture)

or

no more effervescence / bubbles / fizzing

ignore references to colours

allow copper carbonate remains (in the mixture)

1

(c) to remove copper carbonate

allow to remove excess (copper carbonate)

1

(d) electric heater
or
water bath

ignore Bunsen burner

1

(e)

$$92.8 = \frac{\text{mass produced}}{12.5} \times 100$$

allow mass produced =

$$\text{\% yield} \times \frac{\text{max theoretical mass}}{100}$$

1

$$\text{(mass produced)} = \frac{92.8}{100} \times 12.5$$

1

= 11.6 (g)

1

(f) (copper)
does not react with (sulfuric) acid

allow is unreactive

allow will not displace hydrogen

allow is below hydrogen in the reactivity series

ignore is not reactive enough

1

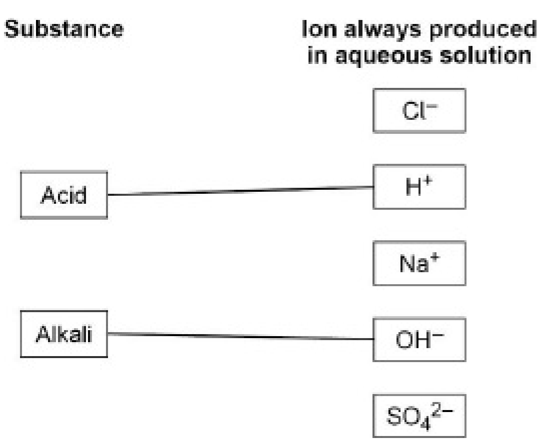
(sodium)
could explode
or
could get too hot

allow (the reaction is) dangerous

1

[10]

6. (a)



*do **not** accept more than **one** line from a box on the left*

2

(b) alkaline

1

(c) pipette

1

(d) burette

1

(e) trial 3

1

(f) any **one** from:

- (hydrochloric acid) not added drop by drop
- did not swirl
- did not rinse apparatus (after previous trial)
- did not use a white tile
- misread pipette / burette

allow measured out too much alkali

1

(g) $\left(25.0 \text{ cm}^3 = \frac{25.0}{1000} = \right) 0.025 \text{ (dm}^3\text{)}$

1

(mass =) 0.025 × 4.00

allow correct use of incorrect / no conversion of volume

1

= 0.1 (g)

1

alternative approach:

$\left(\text{concentration} = \frac{4.00}{1000} = \right)$

0.004 (g/cm^3) (1)

(mass =) 0.004 × 25.0 (1)

= 0.1 (g) (1)

allow correct use of incorrectly determined concentration in g/cm^3

[10]

7. (a) **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

5-6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3-4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1-2

No relevant content

0

Indicative content

- use zinc carbonate and hydrochloric acid

- **add zinc carbonate to the (hydrochloric) acid**
- in a beaker
- stir

- **continue adding until the zinc carbonate is in excess**
- shown by excess solid
- and no more effervescence

- **filter (the reaction mixture)**
- to remove the excess zinc carbonate

- **heat the solution**
- using a water bath or electric heater
- to crystallisation point

- **leave the solution to crystallise**
- pat crystals dry with filter paper

(b) any **two** from:

- zinc

  allow Zn
- zinc oxide

  allow ZnO
- zinc hydroxide

  allow $Zn(OH)_2$

2

[8]