

Name: _____

Chemical Changes part 6 AQA Triple Chemistry

Class: _____

Date: _____

Time: **83 minutes**

Marks: **77 marks**

Comments:

1.

Metals react with acids to produce a salt and a gas.

(a) Which salt is produced when magnesium reacts with hydrochloric acid?

Tick (✓) **one** box.

Magnesium chloride

Magnesium nitrate

Magnesium sulfate

(1)

(b) Which gas is produced when magnesium reacts with hydrochloric acid?

Tick (✓) **one** box.

Carbon dioxide

Chlorine

Hydrogen

Oxygen

(1)

A student investigated the temperature change in the reaction between metals and hydrochloric acid.

This is the method used.

1. Measure 25 cm³ of hydrochloric acid at 20 °C into a container.
2. Add 1 g of a metal.
3. Record the temperature change.
4. Repeat steps 1 to 3 using a different metal.

(c) Draw **one** line from the type of variable to the name of the variable in the investigation.

Type of variable	Name of variable
Dependent variable	Mass of metal
	Temperature change
	Type of metal
Independent variable	Volume of hydrochloric acid

(2)

(d) Which container would be the most suitable to reduce energy transfer with the surroundings?

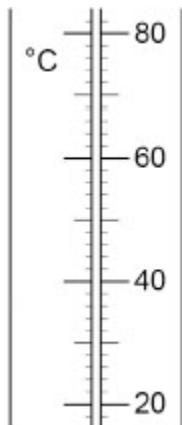
Tick (✓) **one** box.

- A copper can
- A glass beaker
- A polystyrene cup

(1)

(e) **Figure 1** shows part of the scale of the thermometer used in the investigation.

Figure 1



What is the resolution of the thermometer?

Tick (✓) **one** box.

1 °C

2 °C

10 °C

20 °C

(1)

(f) The reaction between a metal and an acid is exothermic.

What happens to the temperature of the mixture during the reaction?

Tick (✓) **one** box.

Decreases

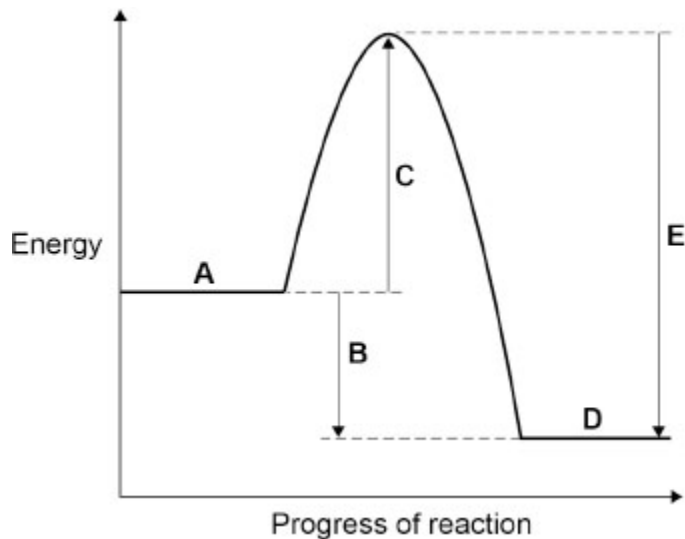
Stays the same

Increases

(1)

Figure 2 shows the reaction profile for the reaction between a metal and an acid.

Figure 2



(g) Which letter in **Figure 2** represents the reactants?

Tick (✓) **one** box.

A B C D E

(1)

(h) Which letter in **Figure 2** represents the activation energy?

Tick (✓) **one** box.

A B C D E

(1)

(i) Which letter in **Figure 2** represents the overall energy change?

Tick (✓) **one** box.

A B C D E

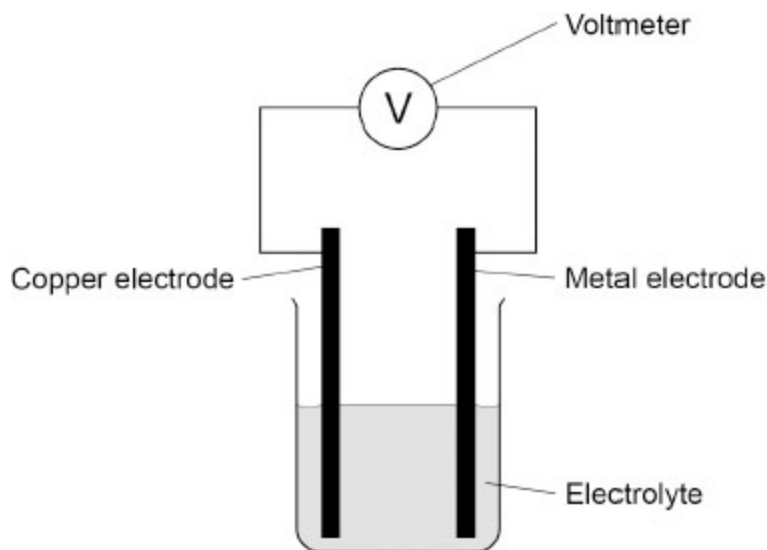
(1)

(Total 10 marks)

2. Cells contain chemicals that react to produce electricity.

A student investigated the voltage produced by four different cells.

The figure below shows the apparatus.



This is the method used.

1. Measure the voltage produced by the cell using metal **A** as the metal electrode.
2. Repeat using different metals as the metal electrode.

The table below shows the results.

Metal electrode	Voltage in volts
A	1.1
B	0.0
C	0.8
D	2.7

(a) Which substance could be used as the electrolyte in the cell in the figure above?

Tick (✓) **one** box.

Pure water

Sodium chloride solution

Solid potassium bromide

(1)

(b) Which metal **A**, **B**, **C** or **D** was copper?

Give **one** reason for your answer.

Use the figure and table above.

Metal _____

Reason _____

(2)

(c) Write the four metals **A**, **B**, **C** and **D** in order of reactivity.

Use the table above.

Most reactive _____

Least reactive _____

(1)

(d) A battery consists of several cells connected together in series.

Each cell has a voltage of 3.6 V.

Calculate the number of cells needed to make a battery of voltage 14.4 V.

Number of cells = _____

(2)

(e) Fuel cells can be used to power electric cars.

Complete the sentence.

Choose the answer from the box.

ammonia	methane	water
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The overall reaction in a hydrogen fuel cell involves the oxidation of hydrogen to produce _____.

(1)

(f) Rechargeable cells can be recharged when an external electrical current is supplied.

Complete the sentence.

When an external electrical current is supplied to a rechargeable cell, the chemical reaction is _____.

(1)

(Total 8 marks)

3.

This question is about electrolysis.

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

Complete the table below.

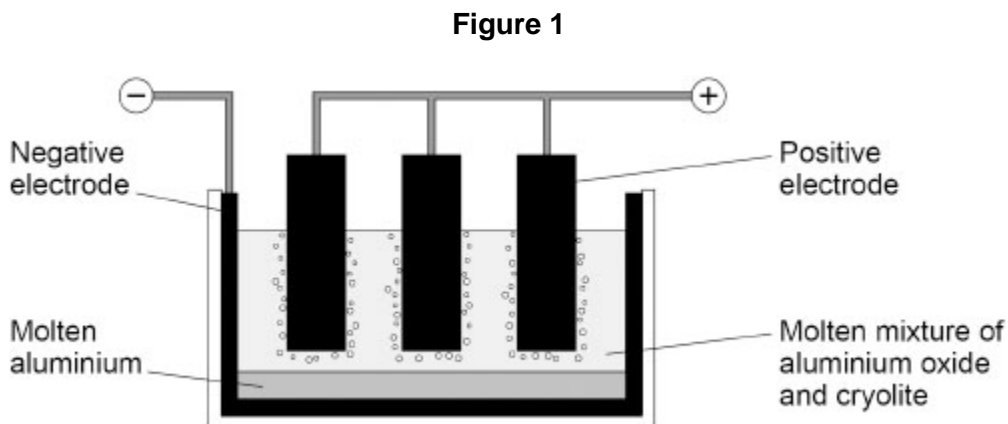
Molten compound	Product at the negative electrode	Product at the positive electrode
Copper chloride		Chlorine
Potassium bromide	Potassium	

(2)

Aluminium is extracted by electrolysis of a molten mixture of aluminium oxide and cryolite.

The products are molten aluminium and oxygen gas.

Figure 1 shows the electrolysis cell.



(b) What is the formula of oxygen gas?

Tick (✓) **one** box.

O O₂ O² 2 O

(1)

(c) Aluminium oxide contains the ions Al³⁺ and O²⁻

Explain why aluminium is produced at the **negative** electrode.

(2)

(d) The melting point of aluminium oxide is 2045 °C.

The melting point of the mixture of aluminium oxide and cryolite is 950 °C.

Explain why the electrolysis uses the mixture instead of pure aluminium oxide.

(2)

(e) The positive electrodes in the electrolysis cell are made of carbon.

Why do the positive electrodes need to be continually replaced?

Tick (✓) **one** box.

Carbon reacts with the aluminium oxide.

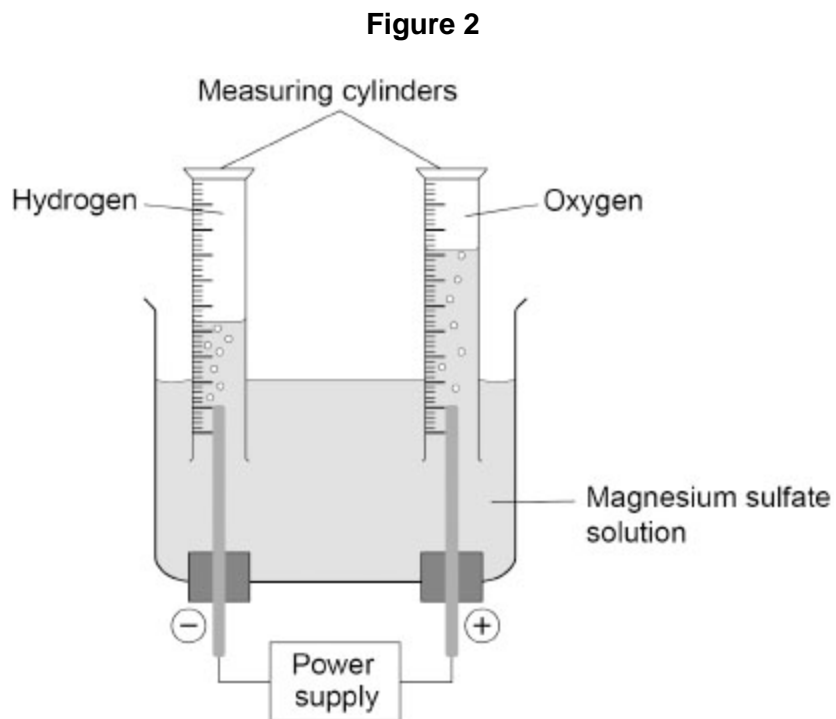
Carbon reacts with the aluminium produced.

Carbon reacts with the oxygen produced.

(1)

A student investigated the electrolysis of magnesium sulfate solution.

Figure 2 shows the apparatus.

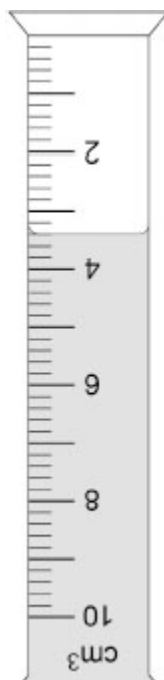


This is the method used.

1. Set the power supply to give a current of 0.05 A.
2. Measure the volume of each gas every minute for 5 minutes.
3. Repeat steps 1 and 2 using a current of 0.10 A in step 1.

(f) **Figure 3** shows a measuring cylinder during the electrolysis.

Figure 3



What is the volume of gas in the measuring cylinder?

Tick (✓) **one** box.

2.7 cm³

3.4 cm³

4.6 cm³

(1)

(g) Hydrogen is produced instead of magnesium at the negative electrode.

Why is hydrogen produced at the negative electrode?

Tick (✓) **one** box.

Hydrogen is less reactive than magnesium.

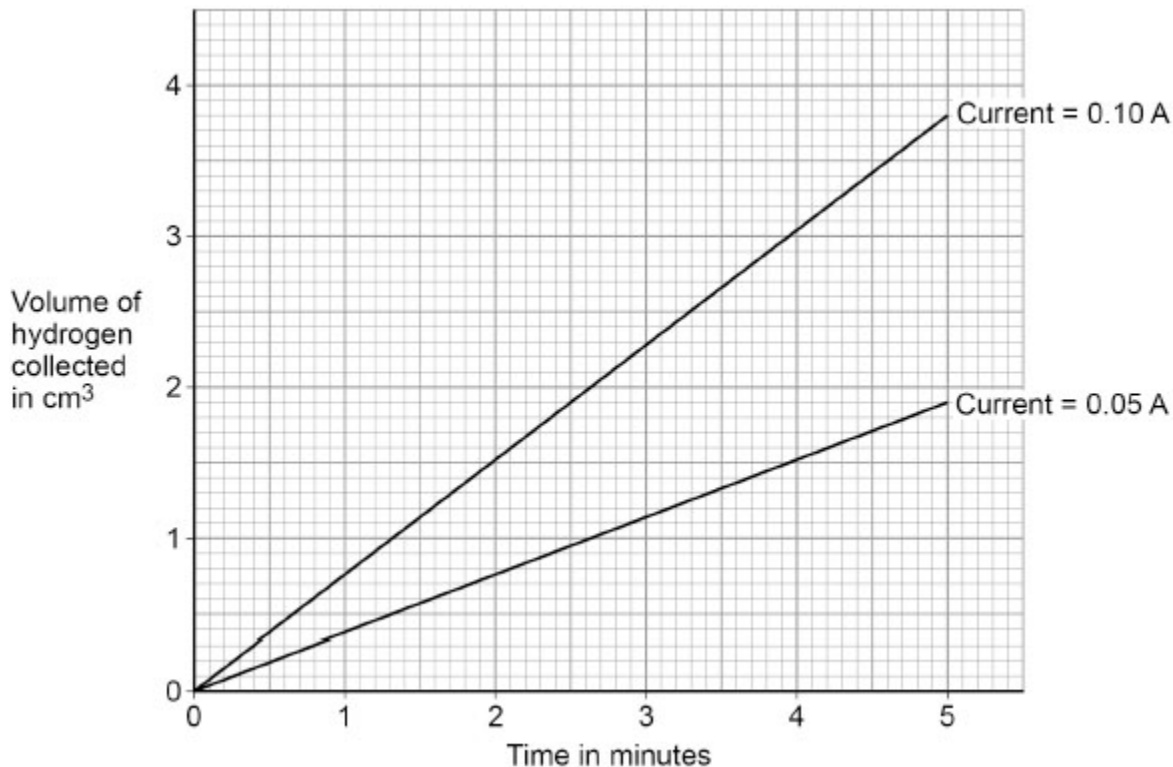
Hydrogen has the same reactivity as magnesium.

Hydrogen is more reactive than magnesium.

(1)

(h) **Figure 4** shows the results for the volume of hydrogen collected.

Figure 4



Which hypothesis explains the results in **Figure 4**?

Tick (✓) **one** box.

The volume of hydrogen collected depends on **both** the current and the time.

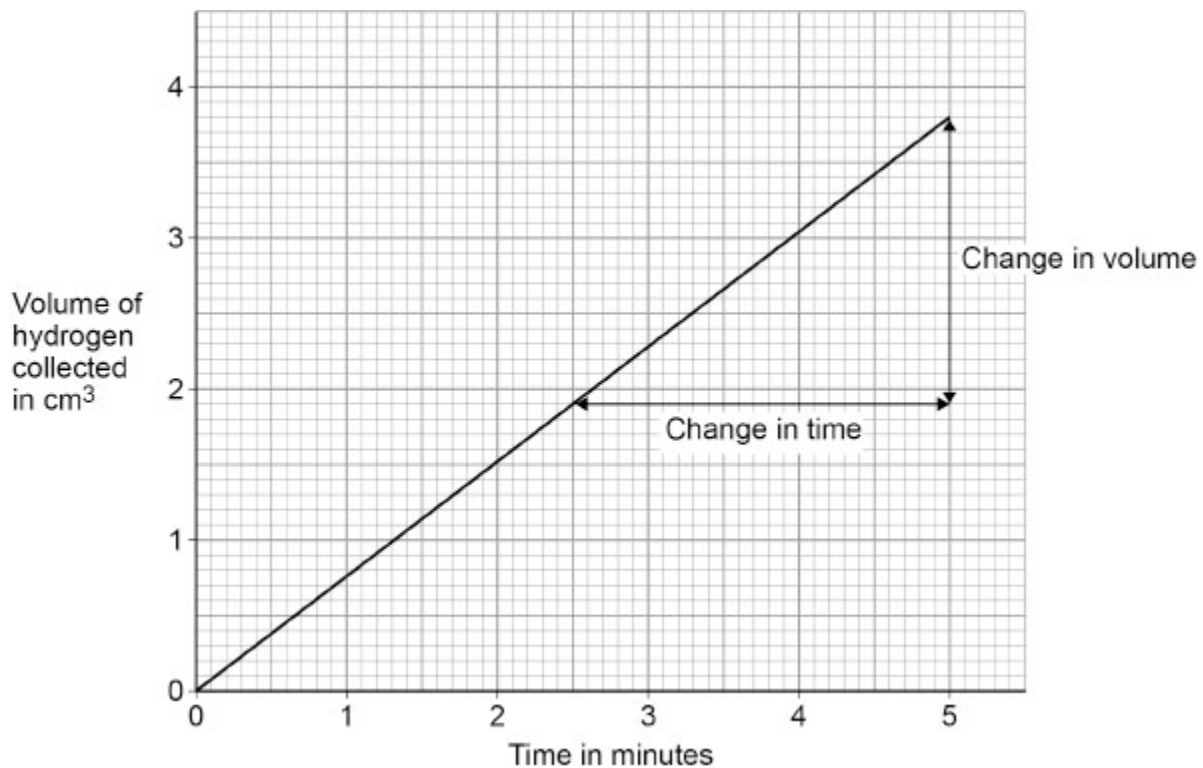
The volume of hydrogen collected depends on the current but **not** the time.

The volume of hydrogen collected depends on the time but **not** the current.

(1)

(i) **Figure 5** is a repeat of part of the graph for current = 0.10 A in **Figure 4**.

Figure 5



Determine the gradient of the graph in **Figure 5**.

Use the equation

$$\text{gradient} = \frac{\text{change in volume}}{\text{change in time}}$$

Change in volume = _____ cm³

Change in time = _____ min

Gradient = _____ cm³/min

(4)

(Total 15 marks)

4.

A student did an experiment to find the volume of an acid that neutralised 25.0 cm³ of an alkali.

This is the method used.

1. Measure 25.0 cm³ of the alkali into a conical flask.
2. Add a few drops of substance **X** to the alkali.
3. Place the conical flask on a white tile.
4. Add the acid to the alkali until a colour change is seen.
5. Measure the volume of acid added.
6. Repeat steps 1 to 5 three more times.

(a) What is the name of this experiment?

Tick (✓) **one** box.

Crystallisation

Distillation

Electrolysis

Titration

(1)

(b) Substance **X** is used in step 2 of the method.

What type of substance is **X**?

(1)

(c) Which piece of equipment is used to add the acid to the alkali in step 4?

Tick (✓) **one** box.

Beaker

Burette

Test tube

(1)

(d) Suggest **one** improvement to step 4 of the method.

(1)

(e) The table below shows the results.

	Trial 1	Trial 2	Trial 3	Trial 4
Volume of acid in cm ³	8.95	9.00	8.85	8.45

Calculate the mean volume of the acid needed to neutralise 25.0 cm³ of the alkali.

Give your answer to 3 significant figures.

Do **not** include the anomalous result.

Mean volume (3 significant figures) = _____ cm³

(4)

- (f) Aqueous solutions of acids and alkalis contain ions.

Draw **one** line from each type of aqueous solution to the ion that is **always** in the aqueous solution.

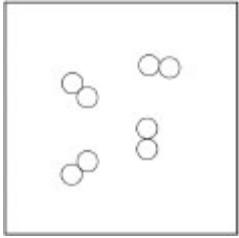
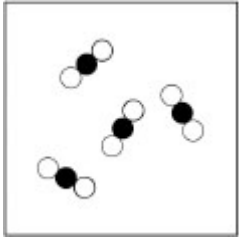
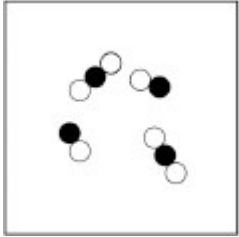
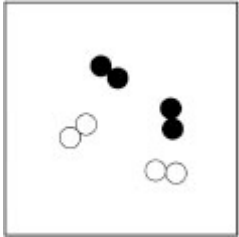
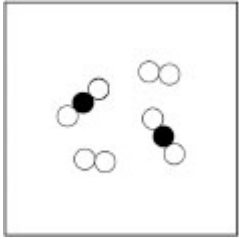
Type of aqueous solution	Ion
<input type="text" value="Acid"/>	<input type="text" value="Cl<sup>-</sup>"/>
	<input type="text" value="H<sup>+</sup>"/>
<input type="text" value="Alkali"/>	<input type="text" value="Na<sup>+</sup>"/>
	<input type="text" value="OH<sup>-</sup>"/>

(2)
(Total 10 marks)

5. This question is about mixtures.

(a) Draw **one** line from each type of mixture to the representation of that mixture.

○ and ● represent atoms of different elements.

Type of mixture	Representation
	
Mixture of compounds	
	
Mixture of a compound and an element	
	

(b) A student had a mixture of salt and sand.

Salt is soluble in water.

Sand is insoluble in water.

Plan a method to obtain pure dry samples of salt and of sand from the mixture.

The figure below shows the chemicals and equipment that can be used.



Mixture of salt and sand



Bottle of water



Beaker



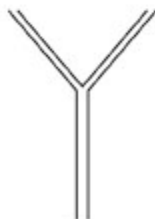
Glass rod



Bunsen burner



Tripod and gauze



Filter paper and funnel



Evaporating basin

(6)

(c) A mixture of salt and sand contained 16.0 g of salt.

The student obtained 13.6 g of salt after separation from the mixture.

Calculate the percentage yield of the salt.

Use the equation

$$\% \text{ yield} = \frac{\text{mass of salt obtained}}{\text{mass of salt in mixture}} \times 100$$

% yield = _____ %

(2)

(Total 10 marks)

6.

This question is about alkalis and acids.

(a) What is the formula of the ion that **all** alkalis contain when in solution?

(1)

A student planned a titration experiment to determine the concentration of a sodium hydroxide solution.

This is the student's plan.

1. Measure 25.0 cm³ of sulfuric acid of known concentration using a pipette.
2. Add the sulfuric acid to a conical flask.
3. Add 3 drops of universal indicator to the conical flask.
4. Place the conical flask on a white tile.
5. Fill a burette with sodium hydroxide solution to the 0.00 cm³ mark.
6. Add sodium hydroxide solution to the conical flask and swirl the flask.
7. Stop adding sodium hydroxide solution when there is a colour change.
8. Record the volume of sodium hydroxide solution used.
9. Repeat steps 1 to 8 until consistent results are obtained.

(b) Suggest **two** improvements to the plan.

Give **one** reason for each improvement.

Improvement 1 _____

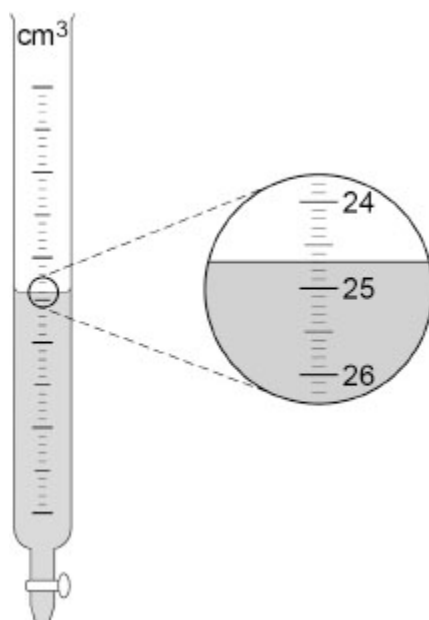
Reason _____

Improvement 2 _____

Reason _____

(4)

(c) The figure below shows the burette after one titration.



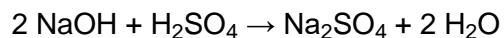
What is the reading on the burette?

_____ cm³

(1)

(d) In a different titration, 25.0 cm³ of 0.216 mol/dm³ sulfuric acid needed 11.25 cm³ of sodium hydroxide solution for neutralisation.

The equation for the reaction is:



Calculate the concentration of the sodium hydroxide solution.

Concentration = _____ mol/dm³

(4)

The table below gives information about solutions of two acids.

Formula of acid	Concentration of solution in mol/dm ³	Percentage (%) of acid molecules that are ionised
HCl	0.1	100
HCN	2.0	0.01

(e) Which is a correct statement about the solutions of HCl and HCN in the table above?

Tick (✓) **one** box.

The HCl is a more concentrated and stronger acid than the HCN.

The HCl is a more concentrated and weaker acid than the HCN.

The HCl is a more dilute and stronger acid than the HCN.

The HCl is a more dilute and weaker acid than the HCN.

(1)

(f) In the table above, the solution of HCl has a lower pH than the solution of HCN.

Explain why.

Use the data in the table above.

(2)

(Total 13 marks)

7.

Aluminium is extracted by the electrolysis of a molten mixture.

The mixture contains aluminium oxide and one other substance.

(a) Aluminium oxide is an ionic compound.

Explain why aluminium oxide has a very high melting point.

(4)

(b) Name the substance added to aluminium oxide to form the mixture.

(1)

(c) Give **one** reason why a mixture is used as the electrolyte.

(1)

Oxygen is produced at the positive electrode.

(d) Write the half equation for the reaction that produces oxygen at the positive electrode.

 →

 +

(2)

(e) The positive electrode must be continually replaced.

Explain why.

(3)
(Total 11 marks)

Mark schemes

1.

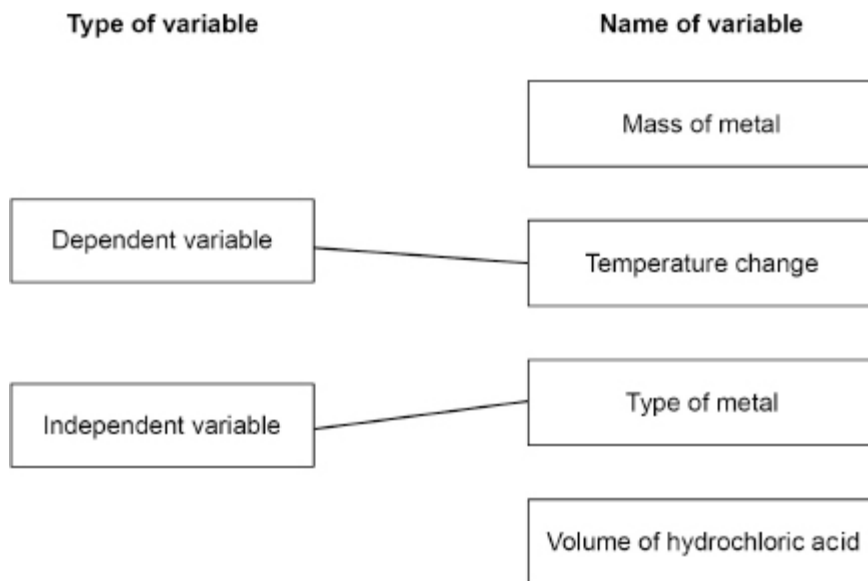
(a) magnesium chloride

1

(b) hydrogen

1

(c)



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

2

(d) a polystyrene cup

1

(e) 2 °C

1

(f) increases

1

(g) **A**

1

(h) **C**

1

(i) **B**

1

[10]

2.

(a) sodium chloride solution

1

(b) (metal)

B

1

(reason)

the two metals must be different

(to produce a voltage)

allow the voltage is 0.0 V

MP2 is dependent upon the award of MP1

1

(c) (most reactive) **D**

A

C

(least reactive) **B**

1

(d)

(number of cells =) $\frac{14.4}{3.6}$

1

= 4

1

(e) water

1

(f) reversed

ignore faster

1

[8]

3.

(a)

molten compound	product at the negative electrode	product at the positive electrode
copper chloride	copper	chlorine
potassium bromide	potassium	bromine

2

(b) O₂

1

(c) aluminium ions are positive(ly charged)

1

(so) are attracted to the negative electrode

allow (and) opposite charges attract

1

- (d) (the mixture) has a lower melting point (than aluminium oxide) 1
 (so) less energy is required 1
- (e) carbon reacts with the oxygen produced 1
- (f) 3.4 cm^3 1
- (g) hydrogen is less reactive than magnesium 1
- (h) the volume of hydrogen collected depends on **both** the current and the time 1
- (i) (change in volume = $3.8 - 1.9 =$) $1.9 \text{ (cm}^3\text{)}$ 1

(change in time = $5 - 2.5 =$)
 2.5 (min)

allow any correct matching pairs of values of volume and time for 2 marks

1

$$(\text{gradient} =) \frac{1.9}{2.5}$$

allow correct use of incorrectly determined values of volume and / or time

1

$$= 0.76 \text{ (cm}^3\text{/min)}$$

allow correct use of incorrectly determined values of volume and / or time

1

[15]

4.

- (a) titration 1
- (b) indicator 1
allow any named indicator
- (c) burette 1
- (d) add the acid dropwise (near the end point)
or
 swirl the flask 1

(e) use of 8.95, 9.00 and 8.85 **only**

1

(mean volume =)

$$\frac{8.95 + 9.00 + 8.85}{3}$$

allow (mean volume =)

$$\frac{26.80}{3}$$

allow correct use of incorrect values of volume

1

$$= 8.933333 \text{ (cm}^3\text{)}$$

1

$$= 8.93 \text{ (cm}^3\text{)}$$

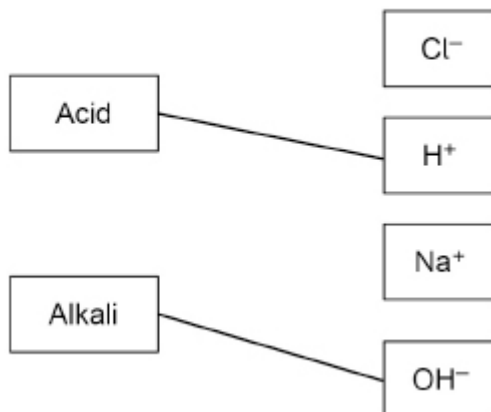
allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question

1

(f)

Type of aqueous solution

Ion



1

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

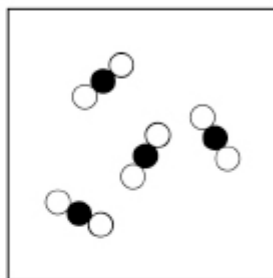
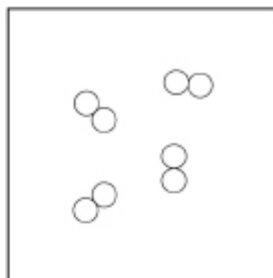
1

[10]

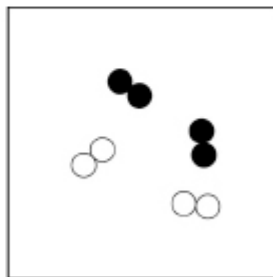
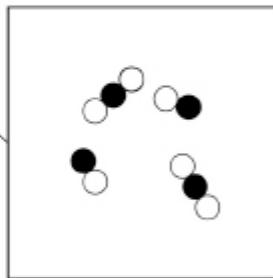
5. (a)

Type of mixture

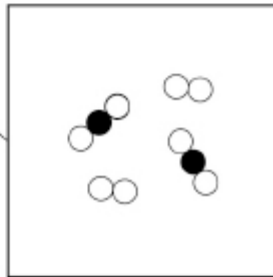
Representation



Mixture of compounds



Mixture of a compound and an element



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

- (b) **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

add mixture to water

- in a beaker
- place beaker on a tripod and gauze
- heat
- using a Bunsen burner
- stir
- using a glass rod
- to dissolve the salt

filter using filter paper and funnel

- to remove the sand
- the sand collects in the filter paper
- rinse the sand
- leave to dry

heat the salt solution

- in an evaporating dish
- heat the solution to half volume
- **or**
- heat to crystallisation point
- leave the remaining solution to form salt crystals
- heat to dryness to obtain salt

- (c)
- $$(\% \text{ yield}) = \frac{13.6}{16.0} \times 100$$
- 1**
- = 85 (%) **1**

[10]

- 6.** (a) OH⁻

1

(b) any **two** from:

*1 mark for improvement, 1 mark for reason
reason must be linked to the corresponding improvement*

(improvement)

use phenolphthalein (instead of universal indicator)

allow methyl orange for phenolphthalein

allow any named single change indicator for phenolphthalein

(reason)

so that the colour change is sharp

allow universal indicator changes colour too gradually

allow universal indicator has too many colour changes

ignore specific colour changes

or

(improvement)

use a pH probe

(reason)

so the pH probe shows a sharper endpoint (than universal indicator)

OR

(improvement)

add the sodium hydroxide solution drop by drop (near the end point)

allow add the alkali drop by drop (near the end point)

(reason)

the volume (of sodium hydroxide solution) used is more accurate

allow so the end point is more accurate

OR

(improvement)

read burette at eye level

allow read (volume) at the bottom of the meniscus

(reason)

the volume (of sodium hydroxide solution) used is more accurate

allow to reduce parallax error

OR

(improvement)

rinse burette with sodium hydroxide **and** pipette with acid

(reason)

remove contaminants

(c) 24.70 (cm³)

allow 24.7 (cm³)

1

(d)

$$\left(\text{moles acid} = \frac{25.0 \times 0.216}{1000} = \right)$$

0.00540

1

(moles alkali = 0.00540 × 2 =)

0.0108

allow correct use of incorrectly determined number of moles of acid

1

(concentration =)

$$0.0108 \times \frac{1000}{11.25}$$

allow correct use of incorrectly determined number of moles of alkali

1

= 0.960 (mol/dm³)

allow = 0.96 (mol/dm³)

alternative approach:

$$\left(\frac{\text{moles acid}}{\text{moles alkali}} = \right)$$

$$\frac{2}{1} = \frac{11.25 \times \text{conc}}{25.0 \times 0.216} \quad (2)$$

allow inverted expression

allow 1 mark for the expression with an incorrect mole ratio

(concentration =)

$$\frac{2 \times 25.0 \times 0.216}{11.25} \quad (1)$$

allow correct use of the expression with incorrect mole ratio

= 0.960 (mol/dm³) (1)

allow = 0.96 (mol/dm³)

1

(e) the HCl is a more dilute and stronger acid than the HCN

1

- (f) (HCl has a) higher concentration of hydrogen ions
allow HCN has a lower concentration of hydrogen ions

1

(because)

concentration of hydrogen ions in HCl is 0.1 (mol/dm³)

and

concentration of hydrogen ions in HCN is 0.0002 (mol/dm³)

1

[13]

7.

- (a) strong electrostatic forces

allow strong forces of attraction

ignore strong ionic bonds

1

between oppositely charged ions

allow between (positive) aluminium ions and (negative) oxide ions

allow between Al³⁺ (ions) and O²⁻ (ions)

1

(which) act in all directions (in the giant structure)

1

(so) need a lot of energy to break (the many strong bonds)

1

- (b) cryolite

allow Na₃AlF₆

1

- (c) the mixture has a lower melting point than aluminium oxide

allow to lower the melting point (of the mixture)

allow to lower the energy demand (of the process)

1

- (d) $2 \text{O}^{2-} \rightarrow \text{O}_2 + 4 \text{e}^-$

allow multiples

allow 1 mark for

$\text{O}^{2-} \rightarrow \text{O}_2 + \text{e}^-$

with no / incorrect balancing numbers

2

- (e) the (positive) electrode is made of carbon / graphite

1

(so) the carbon / graphite reacts with oxygen (produced in the electrolysis)

1

(which) produces carbon dioxide

1

[11]