Cardinal Newman Catholic School

Holy Cross Catholic Multi Academy Company

YEAR 11

CHEMISTRY PAPER 1

Summer 2024

Separate Science practice question booklet

FOUNDATION TIER ONLY

AQA

Name:

"Knowledge through the light of faith"

CARDINAL NEWMAN CATHOLIC SCHOOL

For each Topic in Paper 1 there are 4/5 practice questions.

Remember they can ask you questions linked to all five topics.

How to use this booklet:

1. Complete revision for each topic
2. Put away your notes/resources and try to answer the questions in the best way possible.
3. Look at the mark scheme at the back of the booklet and compare it to your answer – add anything you have missed off in green pen.
4. Go back to the revision guide/your resources to go over anything you are unsure of.

Contents

C1 Atomic Structure and the Periodic table

Q1. This question is about the structure of the atom.

(a) Complete the sentences.

Choose answers from the box.

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

electron	**ion**	**neutron**
nucleus	**proton**	

The centre of the atom is the _____ .

The two types of particle in the centre of the atom are the proton

and the _____ .

James Chadwick proved the existence of the _____ .

Niels Bohr suggested particles orbit the centre of the atom. This type of particle

is the _____ .

The two types of particle with the same mass are the neutron

and the _____ .

(5)

The table below shows information about two isotopes of element **X**.

	Mass number	**Percentage (%) abundance**
Isotope 1	63	70
Isotope 2	65	30

(b) Calculate the relative atomic mass (A_r) of element **X** using the equation:

$$A_r = \frac{\text{(mass number} \times \text{percentage) of isotope 1} + \text{(mass number} \times \text{percentage) of isotope 2}}{100}$$

Use the table above.

Give your answer to 1 decimal place.

_____

_____

_____

_____ A_r = _____ **(2)**

(c) Suggest the identity of element **X**.

Use the periodic table.

Element **X** is _____

(1)

(d) The radius of an atom of element **X** is 1.2×10^{-10} m

The radius of the centre of the atom is $\frac{1}{10000}$ the radius of the atom.

Calculate the radius of the centre of an atom of element **X**.

Give your answer in standard form.

_____

_____

_____

_____

Radius = _____ m

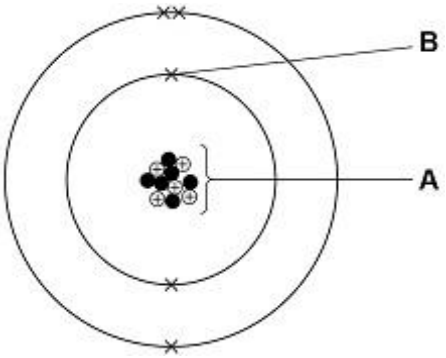
(2)

(Total 10 marks)

Q2. This question is about atomic structure.

Figure 1 represents an atom of element **Z**.

Figure 1



(a) Name the parts of the atom labelled **A** and **B**.

Choose answers from the box.

electron	**neutron**	**nucleus**	**proton**

A _____

B _____

(2)

(b) Which particle has the lowest mass?

Choose the answer from the box.

electron	**neutron**	**nucleus**	**proton**

_____ **(1)**

(c) Which group of the periodic table contains element **Z**?

Use **Figure 1**.

Group _____

(1)

(d) Give the atomic number and the mass number of element **Z**.

Use **Figure 1**.

Choose answers from the box.

1	**5**	**6**	**11**	**16**

Atomic number _____

Mass number _____

(2)

Bromine has two different types of atom.

The atoms have a different number of neutrons but the same number of protons.

(e) What is the name for this type of atom?

Tick (✓) **one** box.

Compound ☐

Ion ☐

Isotope ☐

Molecule ☐

(1)

(f) The different types of bromine atom can be represented as $^{79}_{35}Br$ and $^{81}_{35}Br$

The relative atomic mass (A_r) of bromine is 80

Which statement is true about the number of each type of atom in bromine?

Tick (✓) **one** box.

There are fewer $^{79}_{35}Br$ atoms than $^{81}_{35}Br$ atoms. ☐

There are more $^{79}_{35}Br$ atoms than $^{81}_{35}Br$ atoms. ☐

There are the same number of $^{79}_{35}Br$ atoms and $^{81}_{35}Br$ atoms. ☐

(1)

(Total 8 marks)

Q3. This question is about models of the atom.

(a) Atoms were first thought to be tiny spheres that could not be divided.

Which particle was discovered to change this model of the atom?

Tick (✓) **one** box.

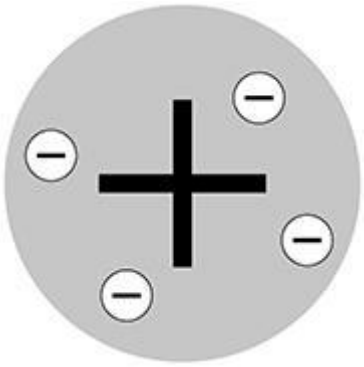
Electron ☐

Neutron ☐

Proton ☐

(1)

(b) The diagram below shows another model of the atom.



What is the name of this model of the atom?

_____

(1)

(c) A scientist fired particles at gold atoms.

Some of these particles were scattered.

The results led to a different model of the atom.

Which type of particle was fired at the gold atoms?

Tick (✓) **one** box.

Alpha	☐
Electron	☐
Neutron	☐
Proton	☐

(1)

(d) Which scientist first suggested that electrons orbit the nucleus at specific distances?

Tick (✓) **one** box.

Bohr	☐
Chadwick	☐
Mendeleev	☐

(1)

(e) The model of the atom used today has three subatomic particles:

- electrons
- neutrons
- protons.

Complete the sentences.

Atoms of the same element have the same atomic number because they have the same number of _____.

Atoms of the same element can have different mass numbers because they have different numbers of _____.

Atoms have no overall charge because they have the same number of _____ and _____.

(3)

(Total 7 marks)

Q4. This question is about Group 1 elements.

(a) Complete **Table 1** to show the electronic structure of a potassium atom.

Table 1

Atom	Number of electrons	Electronic structure
Sodium	11	2,8,1
Potassium	19	

(1)

(b) Why do Group 1 elements have similar chemical properties?

Tick (✓) **one** box.

They have the same number of electron shells. ☐

They have the same number of outer shell electrons. ☐

They have two electrons in the first shell. ☐

(1)

Table 2 shows observations made when lithium, potassium and rubidium react with water.

Table 2

Element	Observations
Lithium	Bubbles slowly Floats Moves slowly
Sodium	1 _____ 2 _____
Potassium	Bubbles very quickly Melts into a ball Floats Moves very quickly Flame
Rubidium	Sinks Melts into a ball Explodes with a flame

(c) Give **two** observations you could make when sodium reacts with water.

Write your answers in **Table 2**. **(2)**

(d) How does the reactivity of the elements change going down Group 1?

_____

_____ **(1)**

(e) Give **two** ways in which the observations in **Table 2** show the change in reactivity going down Group 1.

1 _____

_____

2 _____

_____ **(2)**

(f) Which gas is produced when Group 1 elements react with water?

Tick (✓) **one** box.

Carbon dioxide	☐
Hydrogen	☐
Nitrogen	☐
Oxygen	☐

(1)

(Total 8 marks)

Q5. The halogens are elements in Group 7.

(a) Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom.

_____

(1)

(b) What is the formula for fluorine gas?

Tick **one** box.

F	☐
F_2	☐
F^2	☐
2F	☐

(1)

A student mixes solutions of halogens with solutions of their salts.

The table below shows the student's observations.

	Potassium chloride (colourless)	**Potassium bromide (colourless)**	**Potassium iodide (colourless)**
Chlorine (colourless)		Solution turns orange	Solution turns brown
Bromine (orange)	No change		Solution turns brown
Iodine (brown)	No change	No change	

(d) Explain how the reactivity of the halogens changes going down Group 7.

Use the results in the table above.

_____

_____

_____

_____

_____

_____

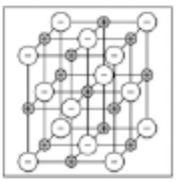
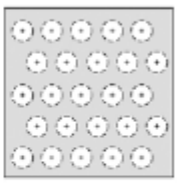
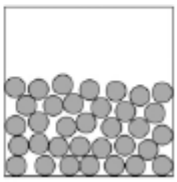
(3)

(Total 5 marks)

C2 Bonding, structure and the properties of matter

Q1. This question is about different substances and their structures.

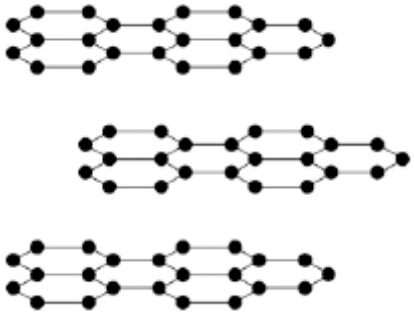
(a) Draw **one** line from each statement to the diagram which shows the structure.

Statement	Structure
The substance is a gas	
The substance is a liquid	
The substance is ionic	
The substance is a solid metal	
	

(4)

(b) **Figure 1** shows the structure of an element.

Figure 1



What is the name of this element?

Tick **one** box.

- Carbon ☐
- Chloride ☐
- Nitrogen ☐
- Xenon ☐

(1)

(c) Why does this element conduct electricity?

Tick **one** box.

It has delocalised electrons ☐

It contains hexagonal rings ☐

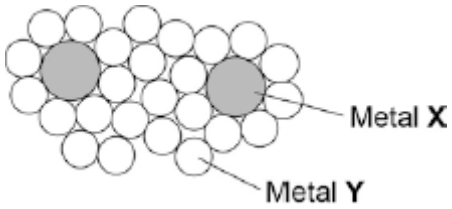
It has weak forces between the layers ☐

It has ionic bonds ☐

(1)

(d) **Figure 2** shows the structure of an alloy.

Figure 2



Explain why this alloy is harder than the pure metal **Y**.

_____

_____

_____ **(2)**

(e) What percentage of the atoms in the alloys are atoms of **X**?

_____

_____

_____

_____

(2)

(f) What type of substance is an alloy?

Tick **one** box.

Compound ☐

Element ☐

Mixture ☐

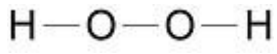
(1)

(Total 11 marks)

Q2. This question is about compounds of oxygen and hydrogen.

Figure 1 represents the structure of hydrogen peroxide.

Figure 1



(a) What is the correct formula of hydrogen peroxide?

Tick (✓) **one** box.

- H2O2 ☐
- HO_2 ☐
- H^2O^2 ☐
- H_2O_2 ☐

(1)

(b) Which type of bonding is shown in **Figure 1**?

Tick (✓) **one** box.

- Covalent ☐
- Ionic ☐
- Metallic ☐

(1)

(c) Hydrogen peroxide decomposes in the presence of a catalyst.

Which elements are often used as catalysts?

Tick (✓) **one** box.

- Alkali metals ☐
- Halogens ☐
- Transition metals ☐

(1)

(d) Hydrogen and oxygen form water.

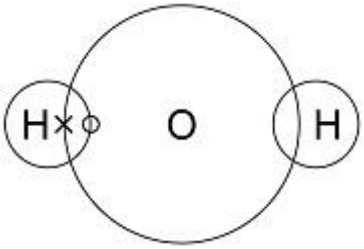
A hydrogen atom contains one electron.

An oxygen atom contains six electrons in the outer shell.

Complete **Figure 3** to show a dot and cross diagram for a water molecule.

Show the outer electrons only.

Figure 3



(2)

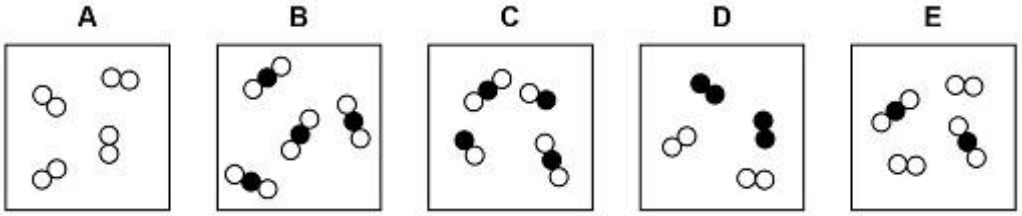
(Total 5 marks)

Q3. This question is about elements, compounds and mixtures.

Figure 1 shows five different substances, **A**, **B**, **C**, **D** and **E**.

○ and ● represent atoms of different elements.

Figure 1



Use **Figure 1** to answer parts (a) to (c)

(a) Which substance is only one compound?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(b) Which substance is a mixture of elements?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(c) Which substance is a mixture of an element and a compound?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

Substances are separated from a mixture using different methods.

(d) Draw **one** line from each method of separation to the substance and mixture it would separate.

Method of separation	Substance and mixture
chromatography	blue food colour from a mixture of food colours
	copper from an alloy of copper and zinc
crystallisation	copper sulfate from copper sulfate solution
	ethanol from a mixture of ethanol and water

(2)

(e) Sand does not dissolve in water. A student separates a mixture of sand and water by filtration.

Draw a diagram of the apparatus the student could use.

You should label:

- where the sand is collected
- where the water is collected.

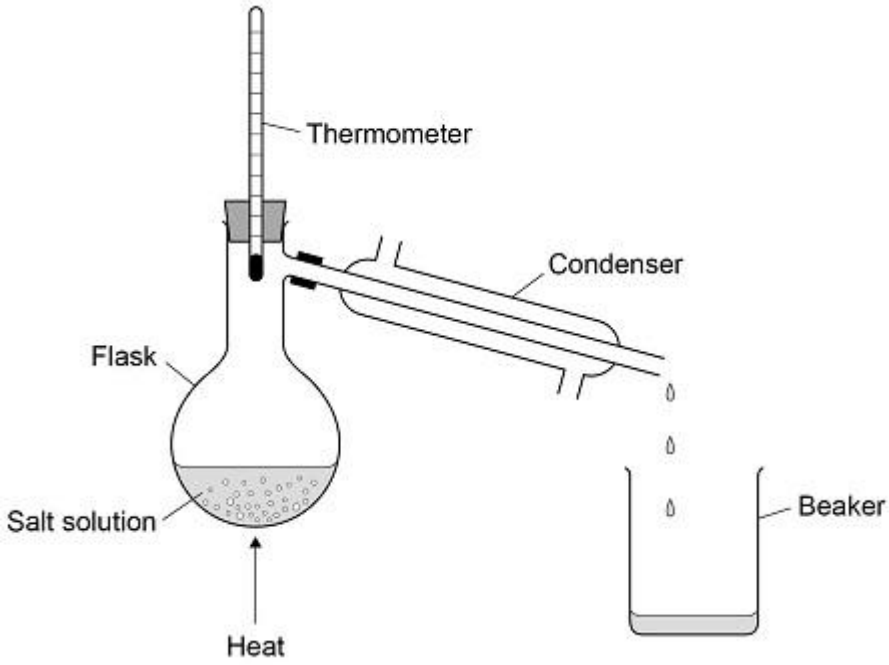
Diagram

(3)

(f) A student distils a sample of salt solution to produce pure water.

Figure 2 shows the apparatus.

Figure 2



What temperature would you expect the thermometer to show?

Tick (✓) **one** box.

0 °C ☐

10 °C ☐

50 °C ☐

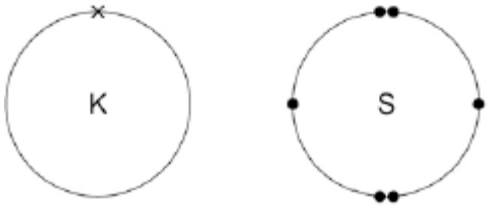
100 °C ☐

(1)

(Total 9 marks)

Q4. **Figure 1** shows the outer electrons in an atom of the Group 1 element potassium and in an atom of the Group 6 element sulfur.

Figure 1



(a) Potassium forms an ionic compound with sulfur.

Describe what happens when **two** atoms of potassium react with **one** atom of sulfur.

Give your answer in terms of electron transfer.

Give the formulae of the ions formed.

_____

_____

_____

_____

_____

_____

_____

_____

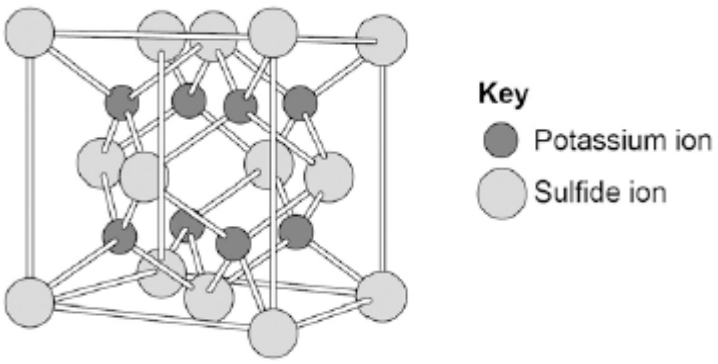
_____

_____

(5)

(b) The structure of potassium sulfide can be represented using the ball and stick model in **Figure 2**.

Figure 2



The ball and stick model is **not** a true representation of the structure of potassium sulfide.

Give **one** reason why.

_____

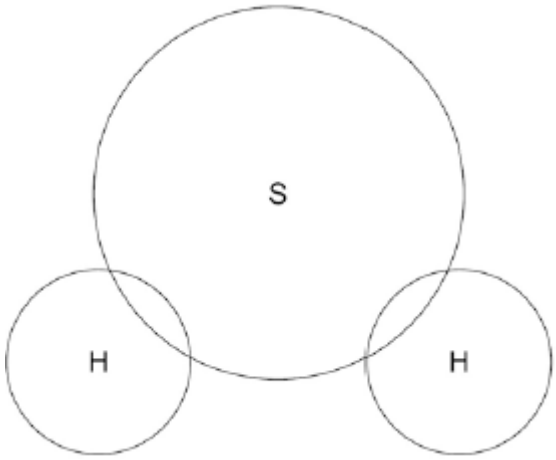
_____

(1)

(c) Sulfur can also form covalent bonds.

Complete the dot and cross diagram to show the covalent bonding in a molecule of hydrogen sulfide.

Show the outer shell electrons only.



(2)

(d) Calculate the relative formula mass (M_r) of aluminium sulfate $Al_2(SO_4)_3$

Relative atomic masses (A_r): oxygen = 16; aluminium = 27; sulfur = 32

_____

_____

_____

Relative formula mass = _____

(2)

(e) Covalent compounds such as hydrogen sulfide have low melting points and do **not** conduct electricity when molten.

Draw **one** line from each property to the explanation of the property.

Property	**Explanation of property**
	Electrons are free to move
	There are no charged particles free to move
Low melting point	
	Ions are free to move
	Weak intermolecular forces of attraction
Does not conduct electricity when molten	
	Bonds are weak
	Bonds are strong

(2)

(f) Ionic compounds such as potassium sulfide have high boiling points and conduct electricity when dissolved in water.

Draw **one** line from each property to the explanation of the property.

Property	**Explanation of property**
High boiling point	There are no charged particles free to move
Conduct electricity when molten	Ions are free to move
	Weak intermolecular forces of attraction
	Bonds are weak
	Bonds are strong
	Electrons are free to move

(2)

(Total 14 marks)

C3 Quantitive Chemistry

Q1. This question is about the extraction of metals.

Element **R** is extracted from its oxide by reduction with hydrogen.

The equation for the reaction is:

$$3\ H_2 + \mathbf{R}O_3 \rightarrow \mathbf{R} + 3\ H_2O$$

(a) The sum of the relative formula masses (M_r) of the reactants ($3\ H_2 + \mathbf{R}O_3$) is 150

Calculate the relative atomic mass (A_r) of **R**.

Relative atomic masses (A_r): H = 1 O = 16

_____

_____

_____

_____

Relative atomic mass (A_r) of **R** = _____

(2)

(b) Identify element **R**.

You should use:

- your answer to part (a)
- the periodic table.

Identity of **R** = _____

(1)

(c) Carbon is used to extract tin (Sn) from tin oxide (SnO_2).

The equation for the reaction is:

$$SnO_2 + C \rightarrow Sn + CO_2$$

Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12 O = 16 Sn = 119

_____

_____

_____

_____

Percentage atom economy = _____ %

(3)

(Total 6 marks)

Q2. This question is about acids, bases and salts.

(a) The student used a pipette to measure 25.0 cm^3 of hydrochloric acid.

Figure 2 shows a pipette.

Figure 2

The pipette is labelled 25.0 ± 0.06 cm^3

Calculate the percentage uncertainty in the volume measured using this pipette.

Use the equation:

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{volume measured}} \times 100$$

_____

_____

_____

Percentage uncertainty = _____ %

(2)

(b) Give **one** advantage of using a pipette rather than using a measuring cylinder to measure the volume of hydrochloric acid.

_____

_____

(1)

(Total 3 marks)

Q3. This question is about silver iodide.

(a) Calculate the percentage atom economy for the production of silver iodide in this reaction.

The equation for the reaction is:

$$AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(aq)$$

Give your answer to 3 significant figures.

Relative formula masses:

(M_r): $AgNO_3 = 170$ NaI = 150 AgI = 235 $NaNO_3 = 85$

Percentage atom economy (3 significant figures) = _____ %

(4)

(b) Tungsten is a metal. The symbol of tungsten is W
Tungsten is produced from tungsten oxide by reaction with hydrogen.

The equation for the reaction is:

$$WO_3 + 3\,H_2 \rightarrow W + 3\,H_2O$$

Calculate the percentage atom economy when tungsten is produced in this reaction.
Use the equation:

$$\text{percentage atom economy} = \frac{184}{(M_r\ WO_3) + (3 \times M_r\ H_2)} \times 100$$

Relative formula masses (M_r): $WO_3 = 232$ $H_2 = 2$

Percentage atom economy = _____%

(2)

Aluminium is extracted from aluminium oxide.

(c) 38% of a rock sample is aluminium oxide.

Calculate the mass of aluminium oxide in 40 kg of the rock sample.

_____

_____

_____

_____

Mass of aluminium oxide = _____ kg

(2)

(d) The formula of aluminium oxide is Al_2O_3

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

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

_____

_____

Relative formula mass (M_r) = _____

(2)

(e) 60.0 kg of aluminium oxide produces a maximum of 31.8 kg of aluminium.

In an extraction process only 28.4 kg of aluminium is produced from 60.0 kg of aluminium oxide.

Calculate the percentage yield.

Give your answer to 3 significant figures.

Use the equation:

$$\text{percentage yield} = \frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$$

_____

_____

_____

_____

_____

Percentage yield = _____%

(3)

(Total 13 marks)

Q5.

This question is about elements in Group 1.

A teacher burns sodium in oxygen.

(a) Complete the word equation for the reaction.

sodium + oxygen ⟶ _____

(1)

(b) What is the name of this type of reaction?

Tick **one** box.

Decomposition	☐
Electrolysis	☐
Oxidation	☐
Precipitation	☐

(1)

(c) The teacher dissolves the product of the reaction in water and adds universal indicator.

The universal indicator turns purple.

What is the pH value of the solution?

Tick **one** box.

1	☐	4	☐	7	☐	13	☐

(1)

(d) A solution of NaOH had a concentration of 40 g/dm^3

What mass of NaOH would there be in 250 cm^3 of the solution?

_____

_____

_____

_____

Mass = _____ g

(2)

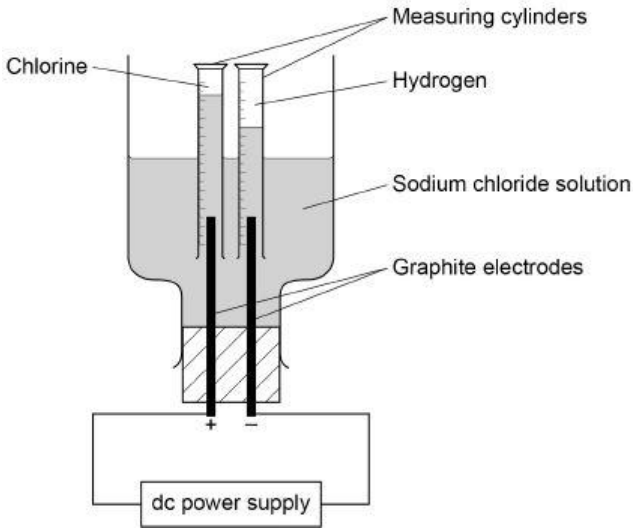
(Total 5 marks)

C4 Chemical changes

Q1. A student investigated the electrolysis of sodium chloride solution.

Figure 1 shows the apparatus.

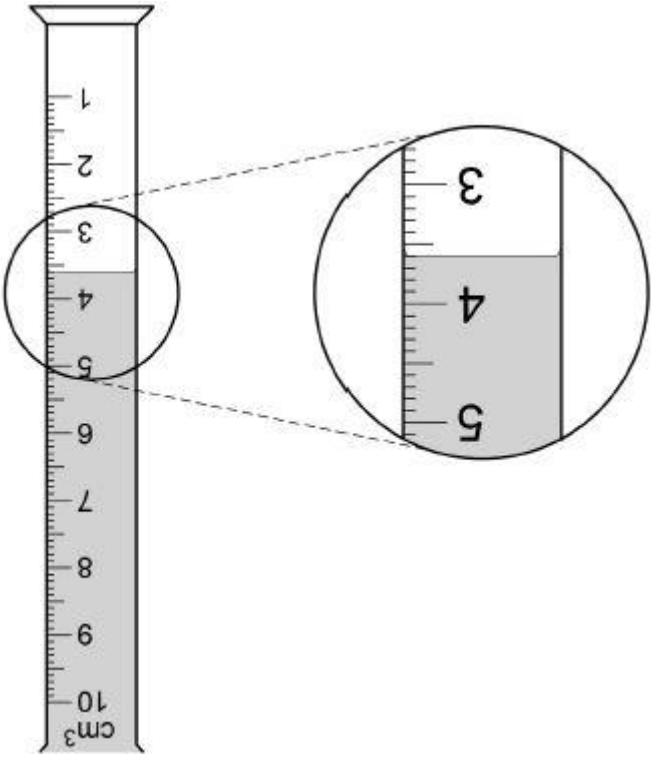
Figure 1



The student measured the volume of gas collected in each measuring cylinder every minute for 20 minutes.

(a) **Figure 2** shows the volume of hydrogen gas collected in the measuring cylinder after 8 minutes.

Figure 2



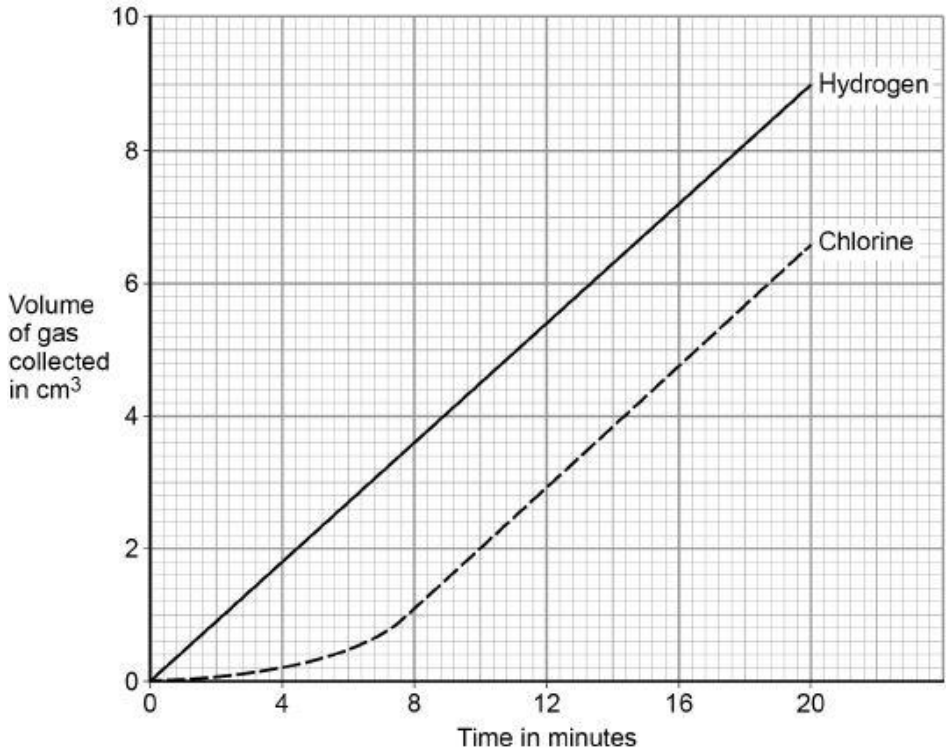
What is the volume of hydrogen gas collected?

Volume = _____ cm^3

(1)

Figure 3 shows the results of the investigation.

Figure 3



(b) Which of the lines on **Figure 3** show that the volume of gas collected is directly proportional to the time?

Tick **one** box.

- Both lines ☐
- Chlorine line only ☐
- Hydrogen line only ☐
- Neither line ☐

(1)

(c) Which of the lines on **Figure 3** show a positive correlation between the volume of gas collected and time?

Tick **one** box.

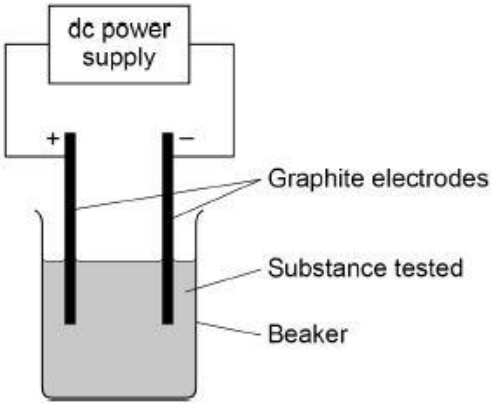
- Both lines ☐
- Chlorine line only ☐
- Hydrogen line only ☐
- Neither line ☐

(1)

A teacher demonstrates the electrolysis of different substances using graphite electrodes.

Figure 4 shows the apparatus used.

Figure 4



(d) Why can graphite conduct electricity?

Tick **one** box.

Graphite exists in layers of atoms. ☐

Graphite has a giant structure. ☐

Graphite has a high melting point. ☐

Graphite has delocalised electrons. ☐

(1)

(e) The teacher demonstrates the electrolysis of:

- molten zinc chloride
- potassium bromide solution.

Complete the table below to predict the products.

Choose answers from the box.

chlorine	**bromine**	**hydrogen**	**oxygen**	**potassium**	**zinc**

Substance electrolysed	**Product at cathode (negative electrode)**	**Product at anode (positive electrode)**
Molten zinc chloride		
Potassium bromide solution		

(4)

(Total 8 marks)

Q2. Soluble salts are formed by reacting metal oxides with acids.

(a) Give **one** other type of substance that can react with an acid to form a soluble salt.

____

(1)

(b) Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

____

(1)

(c) Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____ **(6)**

(Total 8 marks)

Q3. This question is about acids and alkalis.

(a) Which ion do acids produce in aqueous solution?

Tick (✓) **one** box.

H^+ ☐ OH^- ☐ O^{2-} ☐

(1)

(b) Acids react with alkalis.

What is the name of this type of reaction?

Tick (✓) **one** box.

Decomposition ☐

Electrolysis ☐

Neutralisation ☐

Redox ☐

(1)

(c) Balance the equation for the reaction between sulfuric acid and potassium hydroxide.

$$H_2SO_4 + \_\_\_\_ KOH \rightarrow K_2SO_4 + \_\_\_\_ H_2O$$

(1)

(d) Universal indicator turns purple in potassium hydroxide solution.

What is the pH of the solution?

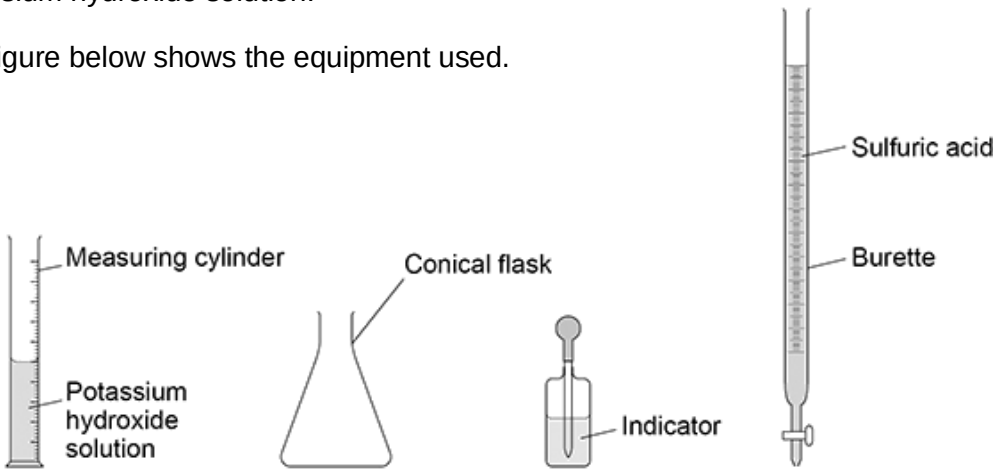
Tick (✓) **one** box.

1 ☐ 4 ☐ 7 ☐ 14 ☐

(1)

A student does a titration to find the volume of sulfuric acid that reacts with 25 cm^3 of potassium hydroxide solution.

The figure below shows the equipment used.



(e) The 25 cm^3 of potassium hydroxide solution is measured with the measuring cylinder.
Which piece of equipment could the student use to measure the 25 cm^3 of potassium hydroxide solution more accurately?

Tick (✓) **one** box.

Beaker	☐
Evaporating basin	☐
Pipette	☐
Test tube	☐

(1)

(f) Describe how the student would use the equipment in the figure above to complete the titration.

(5)

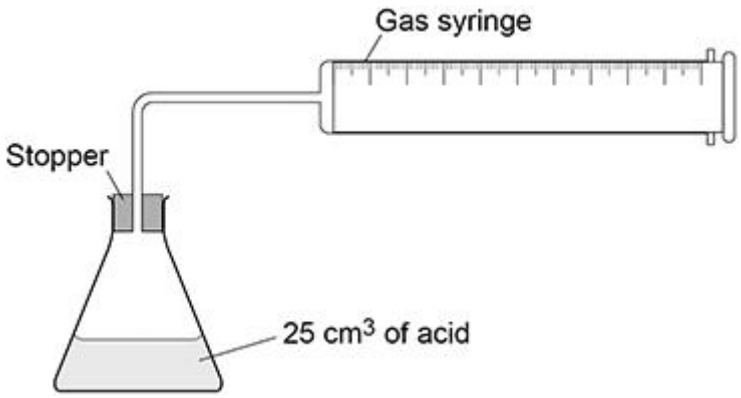
(Total 10 marks)

Q4. This question is about metal carbonates.

A student investigated the reaction of copper carbonate with an acid.

Figure 1 shows the apparatus.

Figure 1

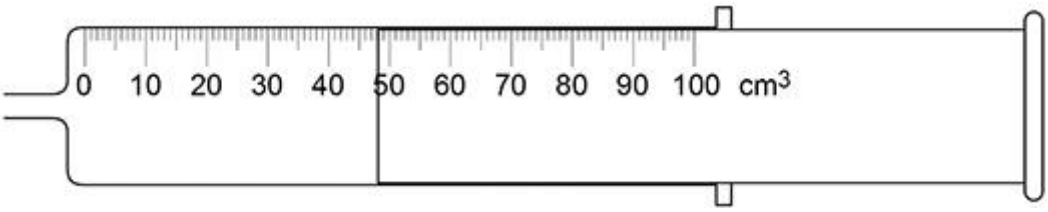


This is the method used.

1. Pour 25 cm^3 of the acid into a conical flask.
2. Weigh 0.10 g of copper carbonate.
3. Remove the stopper and add the copper carbonate to the flask.
4. Quickly replace the stopper.
5. Record the maximum volume of gas collected in the gas syringe.
6. Repeat steps 1 to 5 with different masses of copper carbonate.

(a) **Figure 2** shows the gas syringe during the experiment.

Figure 2



What is the reading on the gas syringe?

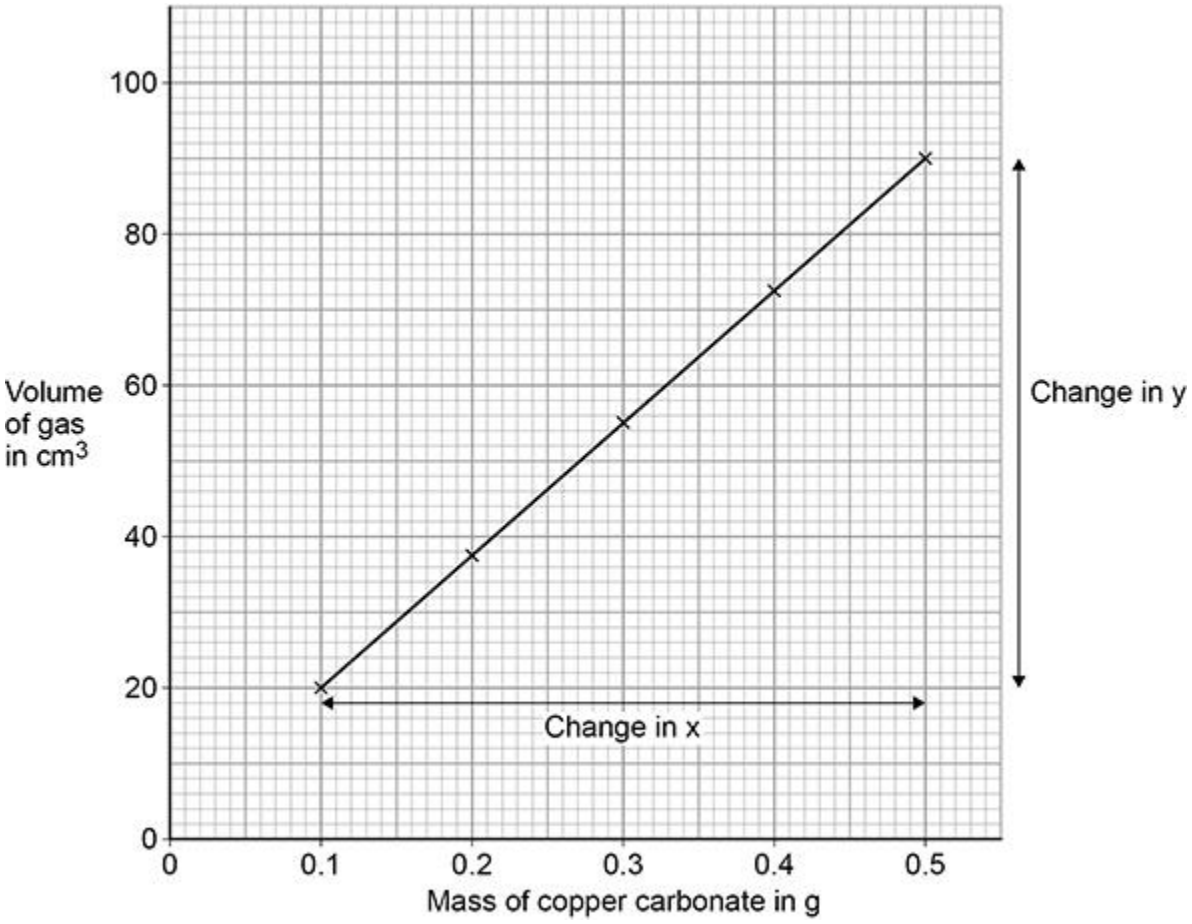
_____ cm^3

(1)

(b) The student plotted the results on a graph.

Figure 3 shows the student's graph.

Figure 3



Determine the gradient of the line of best fit.

You should:

- calculate the values of the change in y and the change in x
- calculate the gradient of the line of best fit.

Change in y = _____ cm^3

Change in x = _____ g

Gradient _____

Gradient = _____ cm^3/g

_____

(4)

(c) Copper chloride was produced in the reaction.
Which acid reacts with copper carbonate to produce copper chloride?

Tick (✓) **one** box.

- Hydrochloric acid ☐
- Nitric acid ☐
- Sulfuric acid ☐

(1)

(d) The reaction between copper carbonate and the acid produced a gas.

What was the gas?

Tick (✓) **one** box.

- Carbon dioxide ☐
- Chlorine ☐
- Hydrogen ☐
- Oxygen ☐

(1)

A different student produced a pure, dry sample of copper chloride using the same reaction.

This is the method used.

1. Add excess copper carbonate to the acid.
2. Filter the mixture.
3. Heat the solution gently until crystals start to form.
4. Leave for 24 hours.
5. Remove the crystals.
6. Rinse with water and dry the crystals.

(e) Why was the solution heated gently in **step 3**?

Tick (✓) **one** box.

- To evaporate acid ☐
- To evaporate copper carbonate ☐
- To evaporate water ☐

(1)

(f) How should the solution be heated gently in **step 3**?

_____

_____

(1)

(Total 9 marks)

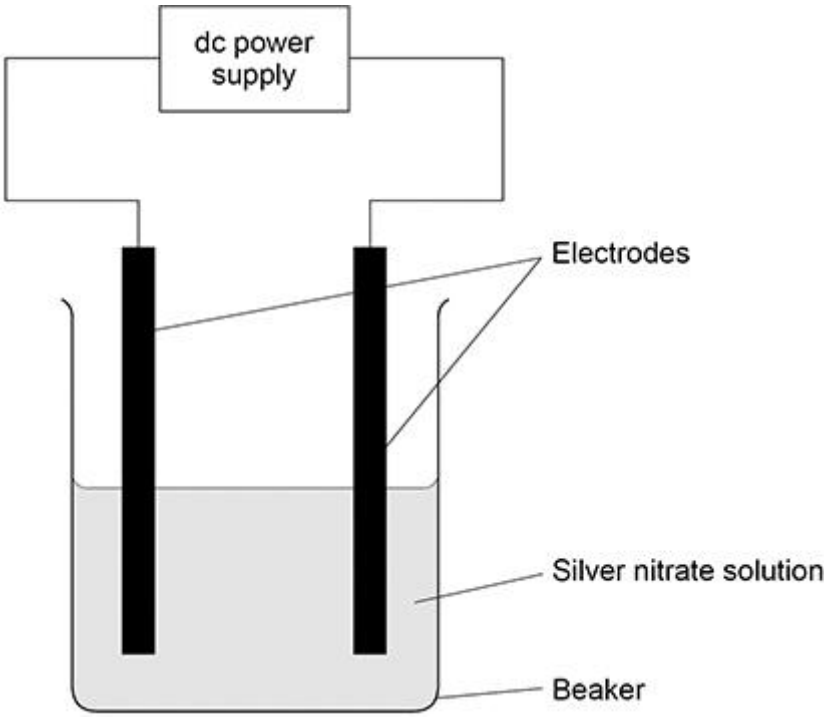
Q5. This question is about electrolysis.

Some students investigated the electrolysis of silver nitrate solution.

This electrolysis produces silver at the negative electrode.

Figure 1 shows the apparatus.

Figure 1



This is the method used.

1. Weigh the negative electrode.
2. Set up the apparatus shown in **Figure 1**.
3. Switch on the power supply.
4. Switch off the power supply after five minutes.
5. Rinse the negative electrode with water and allow to dry.
6. Reweigh the negative electrode.
7. Repeat steps 1 to 6 for different times.

(a) Some silver did not stick to the negative electrode but fell to the bottom of the beaker.

The students needed to weigh this silver.

How could the students separate the silver from the silver nitrate solution?

Tick (✓) **one** box.

By chromatography ☐

By crystallisation ☐

By distillation ☐

By filtration ☐

(1)

(b) A student investigated the electrolysis of two aqueous salt solutions.

Hydrogen is produced at the negative electrode when the metal in the salt solution is more reactive than hydrogen.

Complete **Table 2** to show what the student would **observe** at the negative electrode for each salt solution.

Table 2

Salt solution	**Observation at negative electrode**
Copper sulfate	
Sodium chloride	

(2)

(c) A teacher demonstrates the electrolysis of molten lead bromide.

The products at the electrodes are lead and bromine.

Why should the teacher do the demonstration in a fume cupboard?

_____

_____

(1)

(d) Two other molten compounds are electrolysed.

Complete **Table 3** to show the molten compounds and the products.

Table 3

Molten compound electrolysed	**Product at the negative electrode**	**Product at the positive electrode**
Zinc chloride		
	Potassium	Iodine

(3)

(Total 7 marks)

C5 Energy changes

Q1. This question is about chemical reactions and energy.

Hydrogen reacts with oxygen to produce water.

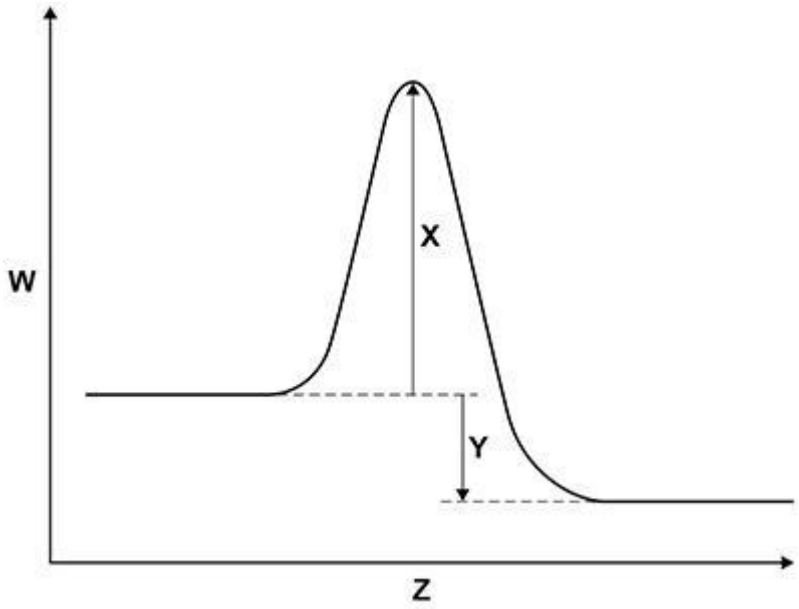
This reaction releases energy.

(a) Complete the word equation for the reaction.

hydrogen + oxygen → _____

(1)

(b) The graph below shows a reaction profile for the reaction between hydrogen and oxygen.



What do the labels **W**, **X**, **Y** and **Z** represent?

Choose answers from the box.

activation energy	**energy**	**overall energy change**
products	**progress of reaction**	**reactants**

W _____

X _____

Y _____

Z _____

(4)

(c) The reaction between hydrogen and oxygen is used in a hydrogen fuel cell.

What is the reason for using this reaction in a fuel cell?

Tick (✓) **one** box.

To produce a change of state	☐
To produce a potential difference	☐
To produce a temperature change	☐

(1)

(d) A student investigated the voltage produced by a chemical cell.

The student used different metals as the electrodes in the cell.

The metals used were:

- copper
- iron
- magnesium.

Which **two** metal electrodes would produce the greatest voltage when used in the chemical cell?

Give **one** reason for your answer.

Metals _____ and _____

Reason _____

_____

(2)

(Total 8 marks)

Q2. A student investigated the reactivity of metals with hydrochloric acid.

This is the method used.

1. Measure 50 cm^3 of hydrochloric acid into a polystyrene cup.
2. Measure the temperature of the hydrochloric acid.
3. Add one spatula of metal powder to the hydrochloric acid and stir.
4. Measure the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1 to 5 three more times.
7. Repeat steps 1 to 6 with different metals.

The table below shows the student's results.

Metal	Temperature increase in °C				Mean temperature increase in °C
	Trial 1	Trial 2	Trial 3	Trial 4	
Cobalt	6	7	5	9	7
Magnesium	54	50	37	55	**X**
Zinc	18	16	18	20	18

(a) Calculate the mean temperature increase **X** for magnesium in the table above.

Do **not** include the anomalous result in your calculation.

_____

_____

_____

_____

X = _____ °C

(2)

(b) Determine the order of reactivity for the metals cobalt, magnesium and zinc.

Use the table above.

Most reactive _____

_____

Least reactive _____

(1)

(c) The range of measurements either side of the mean shows the uncertainty in the mean temperature increase.

Complete the sentence.

Use the table above.

The mean temperature increase for zinc is 18 ± _____°C

(1)

(d) What type of variable is the volume of hydrochloric acid in this investigation?

Tick (✓) **one** box.

Control	☐
Dependent	☐
Independent	☐

(1)

(e) Suggest **one** way of improving **step 3** in the method to give results which are more repeatable.

_____

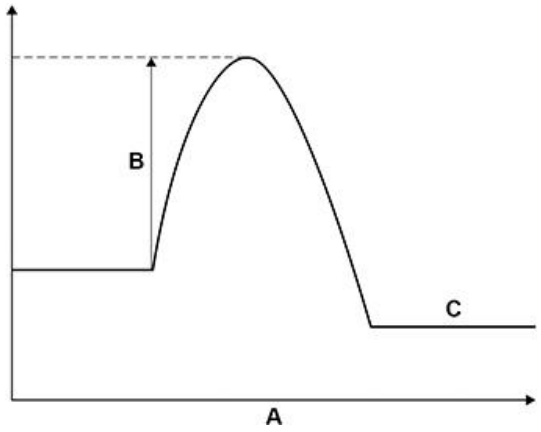
_____

_____

_____

(1)

(f) The figure below shows a reaction profile for the reaction of magnesium with hydrochloric acid.



What do labels **A**, **B** and **C** represent on the figure above?

Choose answers from the box.

activation energy	**energy**	**overall energy change**
products	**progress of reaction**	**reactants**

A _____

B _____

C _____

(3)

(Total 9 marks)

Q3.

This question is about chemical cells and batteries.

(a) Three different types of battery can be used to power a TV remote control.

The table below gives information about these batteries.

	Zinc-carbon battery	**Alkaline battery**	**Nickel-metal hydride battery**
Cost of battery in £ (pounds)	0.17	0.50	1.50
Rechargeable?	No	No	Yes
Time before needing to replace or recharge in months	5	12	8

Give **one** advantage of each type of battery.

Zinc-carbon _____

_____

Alkaline _____

_____

Nickel-metal hydride _____

_____

(3)

(b) **Figure 1** shows a symbol printed on batteries.

Figure 1

This symbol shows that batteries should not be put in household waste.

Suggest why batteries should **not** be put in household waste.

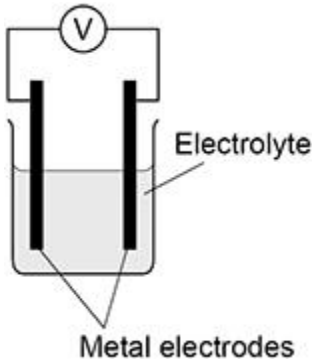
_____

_____

(1)

Figure 2 shows a chemical cell.

Figure 2



(c) The order of reactivity of three metals is shown below.

Iron	(Most reactive)
Tin	↑
Copper	(Least reactive)

Which combination of metal electrodes would give the highest voltage in the chemical cell in **Figure 2**?

Tick (✓) **one** box.

- Copper and iron ☐
- Iron and tin ☐
- Tin and copper ☐

(1)

(d) The voltage produced by the cell in **Figure 2** depends on the type of electrodes and the type of electrolyte.

Suggest **one** other factor that could affect the voltage produced.

_____

_____

(1)

(e) Water is produced in a hydrogen fuel cell.

Complete the word equation to show the reaction that produces water in a hydrogen fuel cell.

_____ + _____ → water

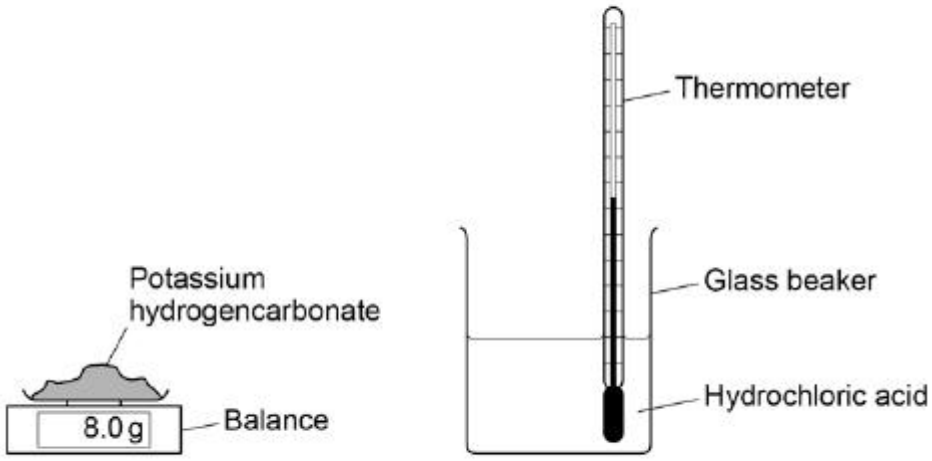
(2)

(Total 8 marks)

Q4. A student investigated the energy change occurring in the endothermic reaction between potassium hydrogencarbonate and hydrochloric acid.

Figure 1 shows the apparatus used.

Figure 1



This is the method used.

1. Measure 50 cm^3 hydrochloric acid into a glass beaker.
2. Measure 1.0 g of potassium hydrogencarbonate.
3. Add the potassium hydrogencarbonate to the hydrochloric acid.
4. Stir until all the potassium hydrogencarbonate has reacted.
5. Record the lowest temperature reached.
6. Repeat steps 1–5 two more times.
7. Repeat steps 1–6 with different masses of potassium hydrogencarbonate.

(a) Which is the most suitable apparatus to use to measure 50 cm^3 of hydrochloric acid?

Tick (✔) **one** box.

- Balance ☐
- Conical flask ☐
- Gas syringe ☐
- Measuring cylinder ☐

(1)

(b) The student used a glass beaker for the reaction.
Suggest **one** change to the apparatus that would improve the accuracy of the results.
Give a reason for your answer.

_____

_____

_____ **(2)**

(c) Which **two** variables should the student keep the same to make this a fair test?

Tick **two** boxes.

- Mass of potassium hydrogencarbonate ☐
- Same balance ☐
- Same thermometer ☐
- Starting temperature of hydrochloric acid ☐
- Volume of hydrochloric acid ☐

(2)

(d) **Figure 2** shows part of the thermometer used to measure the temperature.

What is the temperature reading on the thermometer?

Temperature = _____ °C

(1)

The table shows a set of results.

	Test 1	**Test 2**	**Test 3**
Lowest temperature in °C	16.1	15.8	15.9

(e) What is the range of the lowest temperature?

From _____ °C to _____ °C

(1)

(f) Calculate the mean lowest temperature.

Use the table above.

_____

Mean lowest temperature = _____ °C

(2)

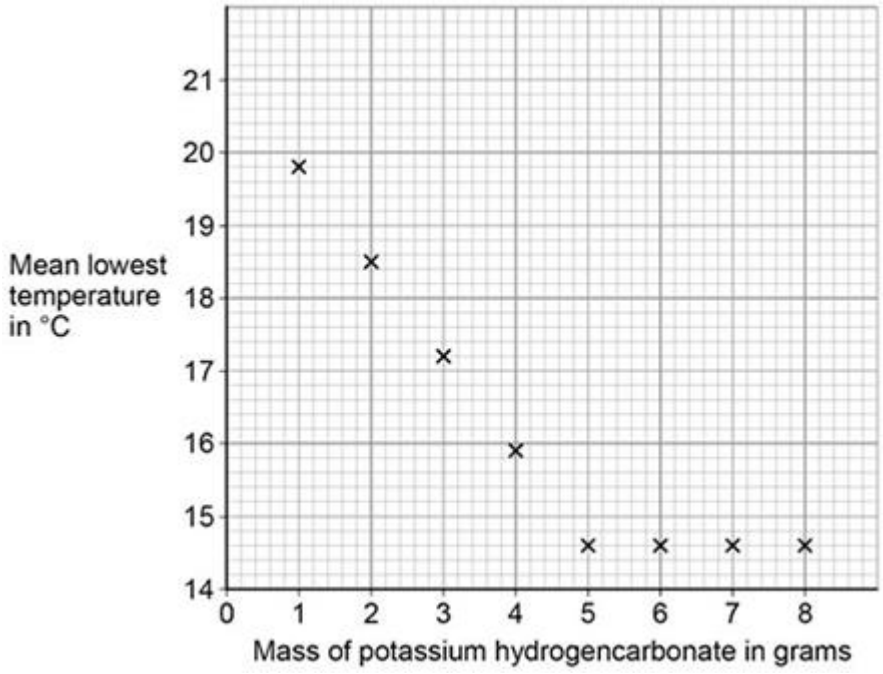
(g) How do the results show that the reaction is endothermic?

_____

_____

(1)

The graph shows the student's results.



(h) Draw **two** straight lines of best fit on the graph above.

(2)

(i) Describe how the lowest temperature changes as the mass of potassium hydrogencarbonate added increases.

_____

_____

_____

_____

_____

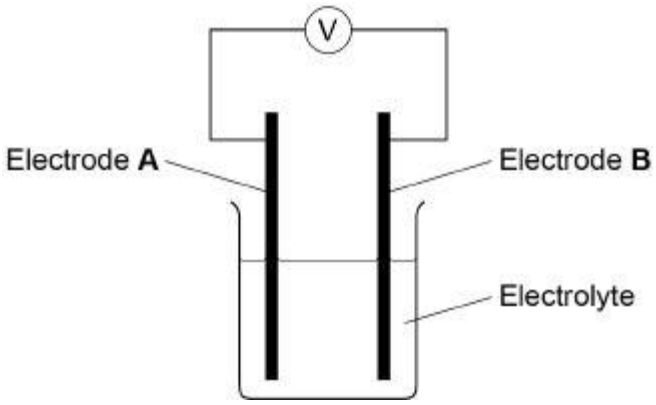
_____

(3)

(Total 15 marks)

Q5. Chemical reactions can produce electricity.

(a) The diagram below shows a simple cell.



Which of these combinations would not give a zero reading on the voltmeter in the diagram above?

Tick **one** box.

Electrode A	Electrode B	Electrolyte	
Copper	Copper	Sodium chloride solution	☐
Zinc	Zinc	Water	☐
Copper	Zinc	Sodium chloride solution	☐
Copper	Zinc	Water	☐

(1)

Alkaline batteries are non-rechargeable.

(b) Why do alkaline batteries eventually stop working?

_____

_____

(1)

(c) Why can alkaline batteries **not** be recharged?

_____

_____

(1)

Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

(d) Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

_____ H_2 + _____ $\longrightarrow$ _____ H_2O

(2)

(e) The table below shows data about different ways to power electric cars.

	Hydrogen fuel cell	**Rechargeable lithium-ion battery**
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3
Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use the table above and your own knowledge.

(6)

(Total 11 marks)

Mark schemes

C1 Atomic Structure

Q1. (a) nucleus

1

neutron

1

neutron

1

electron

1

proton

1

must be in this order

(b) $(A_r)\ \frac{(63 \times 70) + (65 \times 30)}{100}$

1

= 63.6

1

*an answer of 63.6 scores **2** marks*

(c) copper / Cu

*allow ecf from answer to question **(b)***

1

(d) $\frac{1.2 \times 10^{-10}}{10\,000}$

or

$1.2 \times 10^{-10} \times 1 \times 10^{-4}$

1

$= 1.2 \times 10^{-14}$ (m)

1

*an answer of 1.2×10^{-14} (m) scores **2** marks*
*a correct answer not in standard form scores **1** mark*

[10]

Q2.

(a) **A** nucleus

1

B electron

1

(b) electron

1

(c) 3 / three

1

(d) (atomic number) 5

1

(mass number) 11

1

(e) isotope

1

(f) there are the same number of $^{79}_{35}Br$ atoms and $^{81}_{35}Br$ atoms

1

[8]

Q3.

(a) electron

1

(b) plum pudding

1

(c) alpha

1

(d) Bohr

1

(e) protons

1

neutrons

1

protons (and) electrons
either order

1

[7]

Q4. (a) 2,8,8,1

1

(b) they have the same number of outer shell electrons

1

(c) any **two** from:
- bubbles (very) quickly
- melts (into a ball)
- floats
- moves (very) quickly

allow flame

2

(d) (reactivity) increases (down the group)

1

(e) any **two** from:
- increasing speed of movement
- increasing rate of bubble production
- doesn't melt → melts
- no flame → flame

or
flame → explosion

2

(f) hydrogen

1

[9]

Q5.

(a) 7

1

(b) F_2

1

(c) the reactivity decreases (going down Group 7)
allow the reactivity decreases from chlorine to iodine

1

(because) chlorine displaces bromine and iodine
allow (because) chlorine has two reactions
allow (because) neither bromine nor iodine can displace chlorine

1

(and) bromine displaces iodine **or** iodine does not react
allow (and) bromine has one reaction
***or** iodine has no reactions*
allow (and) iodine cannot displace bromine

1

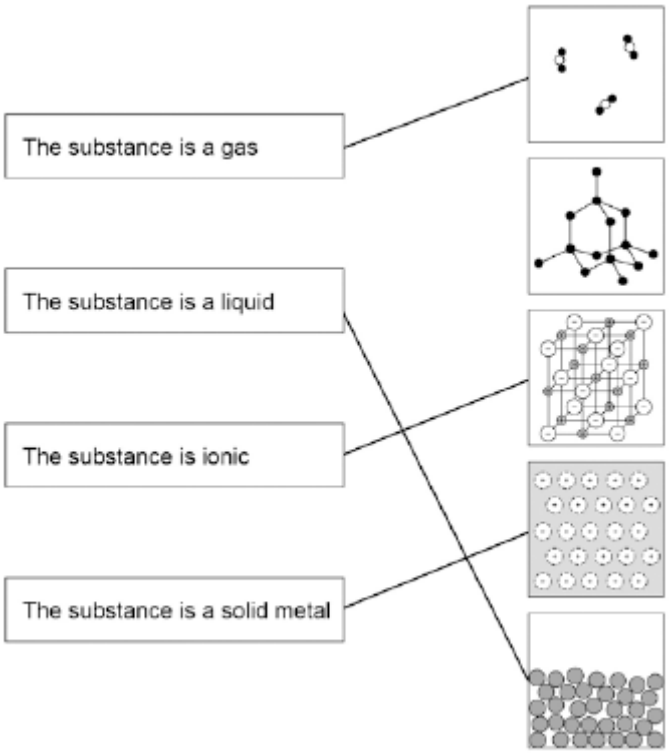
*an answer of 75 (%) scores **2** marks*

[5]

C2 Bonding, structure and the properties of matter

Q1.

(a) **Statement** **Structure**



more than one line drawn from a variable negates the mark **4**

(b) Carbon **1**

(c) It has delocalised electrons **1**

(d) the atoms / particles / ions are different sizes **1**
*do **not** accept molecules*

so there are no rows / layers to slide **1**
accept the layers are disrupted

(e) $\frac{2}{27} \times 100$ **1**

7.4% **1**

*allow 7.4% with no working shown for **2** marks*

(f) Mixture **1**

[11]

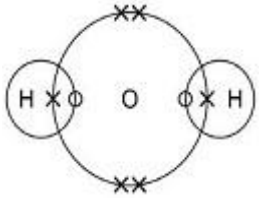
Q2.

(a) H_2O_2 **1**

(b) covalent **1**

(c) transition metals **1**

(d)



*scores **2** marks*
allow dots, crosses, circles or $e^{(-)}$ for electrons

1 bonding pair of electrons in the right hand overlap
*do **not** accept any change to the number of electrons in the left hand overlap*

1

4 non-bonding electrons on oxygen
*do **not** accept non-bonding electrons on hydrogen*
ignore inner shell electrons drawn on oxygen

1

[5]

Q3.

(a) B

1

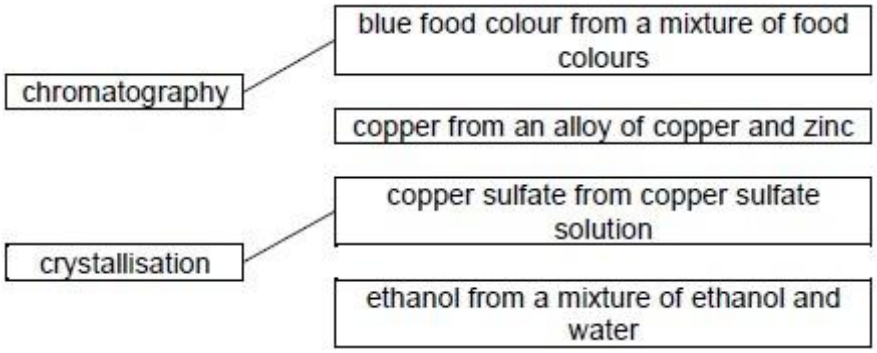
(b) D

1

(c) E

1

(d)



additional line from a box negates the mark for that box

2

(e) (filter) funnel containing filter paper

1

suitable vessel for collecting filtrate

1

sand **and** water labelled in correct place

1

(f) 100 °C

1

[9]

Q4.

(a) electrons transferred from potassium to sulfur

1

two potassium atoms each lose one electron

1

forming K^+ / 1+ ions

1

sulfur atoms gain 2 electrons

1

forming S^{2-} / 2− ions

1

(b) there are no gaps / sticks between the potassium ions and sulfide ions

1

(c) (two) shared pairs between H and S

1

rest correct - no additional hydrogen electrons and two non-bonding pairs on sulfur
second mark dependent on first

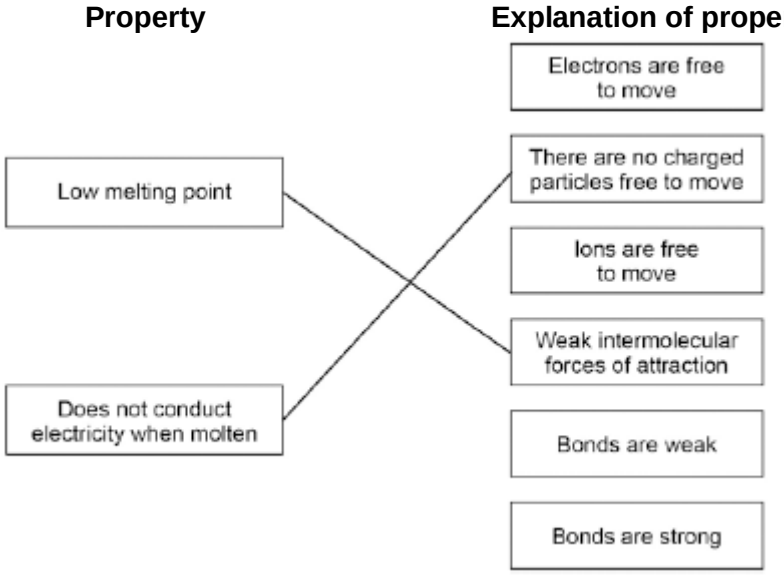
1

(d) 342

2

*allow **1** mark for evidence of (2 × 27) + 3[32 + (16 × 4)]*

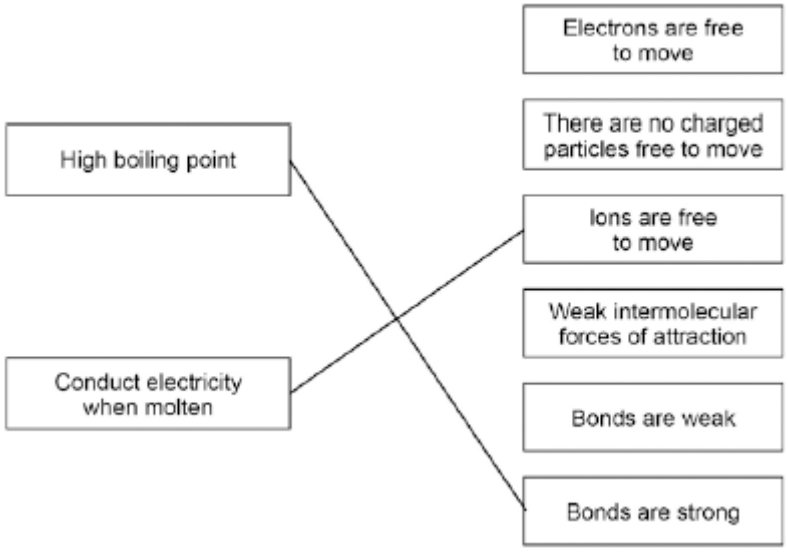
(e)



more than one line drawn from a variable negates the mark

2

(f)



more than one line drawn from a variable negates the mark

2

[14]

C3 Quantitive Chemistry

Q1.

(a) ($3 \times M_r$ H_2O = 3 × (2 + 16) =) 54
(A_r **R** = 150 – 54 =) 96
ignore units

1

alternative approach:
(M_r **R**O_3 = 150 – 6 =) 144 (1)
(A_r **R** = 144 – (3 × 16) =) 96 (1)
ignore units

1

(b) **(R** =) molybdenum / Mo
*allow ecf from question **(a)***

1

(c) (total M_r of reactants) = 163

1

(% atom economy =) $\frac{119}{163}$ (×100)
allow correct use of an incorrectly calculated value of total M_r

1

= 73 (%)
allow 73.00613 (%) correctly rounded to at least 2 significant figures

1

(d) **Level 2:** Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. They are not logically linked.

1–2

No relevant content

0

Indicative content

- carbon and iron are the cheapest reactants
- hydrogen is the most expensive reactant
- separating solid products is expensive
- separating solid products is time consuming
- in method 1, tungsten needs to be separated from tungsten carbide
- in method 1, some tungsten is lost as tungsten carbide
- in method 1, the carbon dioxide produced will escape
- in method 2, the water vapour produced will escape
- in method 2, no separation of solids is needed
- in method 3, tungsten needs to be separated from iron oxide

[10]

Q2. (a)

$\frac{0.06}{25(.0)} \times 100$

1

= 0.24 (%)

1

(b) (pipette) measures volume more accurately
or
(pipette has a) smaller (percentage) uncertainty
allow (pipette is) more accurate

1

[3]

Q3. (a) (total M_r = 170 + 150) = 320

allow (235 + 85) = 320

1

(% atom economy =) 235

$\frac{235}{320} \times 100$

allow correct use of incorrectly calculated total M_r

1

= 73.4375 (%)

1

= 73.4 (%)

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

1

(b)

*an answer of 77 (%) scores **2** marks*
*an answer of 78.63247863 (%) correctly rounded to at least 2 significant figures scores **1** mark*

$\frac{184}{(232 + 6)} \times 100$

1

= 77 (%)

allow 77.31092437 (%) correctly rounded to at least 2 significant figures

1

(c)

*an answer of 15 (kg) scores **2** marks*

$\frac{38}{100} \times 40$

1

= 15 (kg)

allow 15.2 (kg)

1

(d)

*an answer of 102 scores **2** marks*

(2 x 27) + (3 x 16)

1

= 102

ignore units

1

(e)

*an answer of 89.3 (%) scores **3** marks*

$\frac{28.4}{31.8} \times 100$

1

= 89.3081761 (%)

allow 89.3081761(%) correctly rounded to at least 2 significant figures

1

= 89.3 (%)

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

1

[13]

Q5. (a) sodium oxide

allow Na_2O

1

(b) oxidation

1

(c) 13

1

(f) $(\text{volume} =) \frac{250}{1000}$ or $\frac{1}{4}$

or 0.25 (dm^3)

1

or

$(\text{mass per } cm^3 =) \frac{40}{1000}$ (g)

or 0.04 (g)

$(\frac{250}{1000} \times 40 =) 10$ (g)

1

*an answer of 10 (g) scores **2** marks*

[5]

C4 Chemical changes

Q1. (a) 3.6 (cm^3)

1

(b) hydrogen line only

1

(c) both lines

1

(d) graphite has delocalised electrons

1

(e) **cathode** **anode**

zinc (1) chlorine (1)

*do **not** accept chloride*

*allow **1** mark if chlorine and zinc the wrong way around*

1+1

hydrogen (1) bromine (1)

*do **not** accept bromide*

*allow **1** mark if bromine and hydrogen the wrong way around*

1+1

[8]

Q2. (a) any **one** from:

- metal
- (metal) hydroxide
  allow ammonium hydroxide
- (metal) carbonate
  allow ammonium carbonate
- alkali
  allow soluble base
  allow ammonia

1

allow named example
allow correct formula
ignore base

(b) $Ca(NO_3)_2$

allow $Ca^{2+}(NO_3^-)_2$

1

(c) **Level 3:** The method would lead to the production of a valid outcome. All 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 magnesium oxide and sulfuric acid
- add sulfuric acid to a beaker
- warm sulfuric acid
- add magnesium oxide
- stir
- continue adding until magnesium oxide is in excess
- filter
- using a filter paper and funnel
- to remove excess magnesium oxide
- heat solution in an evaporating basin
- to crystallisation point
- leave to crystallise
- pat dry with filter paper

credit may be given for diagrams

[8]

Q3. (a) H^+

1

(b) neutralisation

1

(c) $H_2SO_4 + 2\ KOH \rightarrow K_2SO_4 + 2\ H_2O$

allow multiples

1

(d) 14

1

(e) pipette

1

(f) add potassium hydroxide (solution) to the (conical) flask

1

add (a few drops of) indicator

1

add the (sulfuric) acid (from the burette)

1

until the colour (of the indicator) changes

1

read the volume from the burette

1

[10]

Q4. (a) 48 (cm^3)

1

(b) (change in y =) 70 (cm^3)

1

(change in x =) 0.4 (g)

1

(gradient =) $\frac{70}{0.4}$

allow correct use of incorrectly derived values for change in y and / or change in x

1

= 175 (cm^3/g)

1

(c) hydrochloric acid

1

(d) carbon dioxide

1

(e) to evaporate water

1

(f) using a (boiling) water bath
or
using an electric heater

1

[9]

Q5. (a) by filtration

1

(b) (copper sulfate solution) pink / orange / red / brown solid

allow copper plating
allow metal for solid

1

(sodium chloride solution) bubbles / effervescence / fizzing

*if no other mark awarded allow **1** mark for copper **and** hydrogen*

1

(c) toxic / poisonous (fumes)

allow harmful / corrosive (fumes)
ignore dangerous / deadly / lethal

1

(d)

Molten compound electrolysed	**Product at the negative electrode**	**Product at the positive electrode**
(zinc chloride)	zinc (1)	chlorine (1)
potassium iodide	(potassium)	(iodine)

allow **1** mark if zinc and chlorine the wrong way round

2
1

[7]

C5 Energy changes

Q1. (a) water

allow H_2O
*do **not** accept energy*

1

(b) W = energy **1**

X = activation energy **1**

Y = overall energy change

1

Z = progress of reaction

1

(c) to produce a potential difference

1

(d) magnesium **and** copper

1

(the metals) have the largest difference in reactivity

1

[8]

Q2. (a) $\frac{54 + 50 + 55}{3}$

1

= 53 (°C)

*if no other mark awarded allow **1** mark for* $\frac{54 + 50 + 37 + 55}{4}$ *= 49 (°C)*

1

(b) (most reactive) magnesium zinc
(least reactive) cobalt

*allow ecf from question **(a)***

1

(c) (18 ±) 2 (°C)

1

(d) control

1

(e) use the same mass of metal / powder

1

(f) (A) progress of reaction

1

(B) activation energy

1

(C) products

1

[9]

Q3. (a) (zinc-carbon) cheap(est)

1

(alkaline) long(est) lasting

1

(nickel-metal hydride) rechargeable

allow do not have to be thrown away

1

(b) any **one** from:
- (metal / alkaline waste) can be toxic / harmful / corrosive
  allow (batteries) can ignite / explode
- (metal / alkaline waste) could cause pollution in landfill sites
- recycling would save resources
  ignore dangerous

1

(c) copper and iron

1

(d) any **one** from:
- temperature (of electrolyte / solution)
- concentration (of electrolyte / solution)

ignore type of electrode / electrolyte
allow size / mass / length of electrode
allow surface area of electrode
allow distance between electrodes
allow volume of solution / electrolyte

1

(e) hydrogen
allow H_2

1

oxygen
allow O_2

1

[8]

Q4. (a) measuring cylinder

1

(b) use a polystyrene cup
allow insulate the beaker and / or use a lid

1

better insulator

or

reduces energy transfer from the surroundings

1

(c) starting temperature of hydrochloric acid

1

volume of hydrochloric acid

1

(d) 21.4 (°C)

1

(e) 15.8 (°C) to 16.1 (°C)

allow 16.1 (°C) to 15.8 (°C)

1

(f) $\frac{16.1 + 15.8 + 15.9}{3}$

=15.9 (°C)

*an answer of 15.9(333..) (°C) scores **2** marks*

1

allow 15.9(333..) (°C)

1

(g) temperature decreases

1

(h) straight line from (1.0, 19.8) to (5.0, 14.6)

ignore continuation of line in either direction

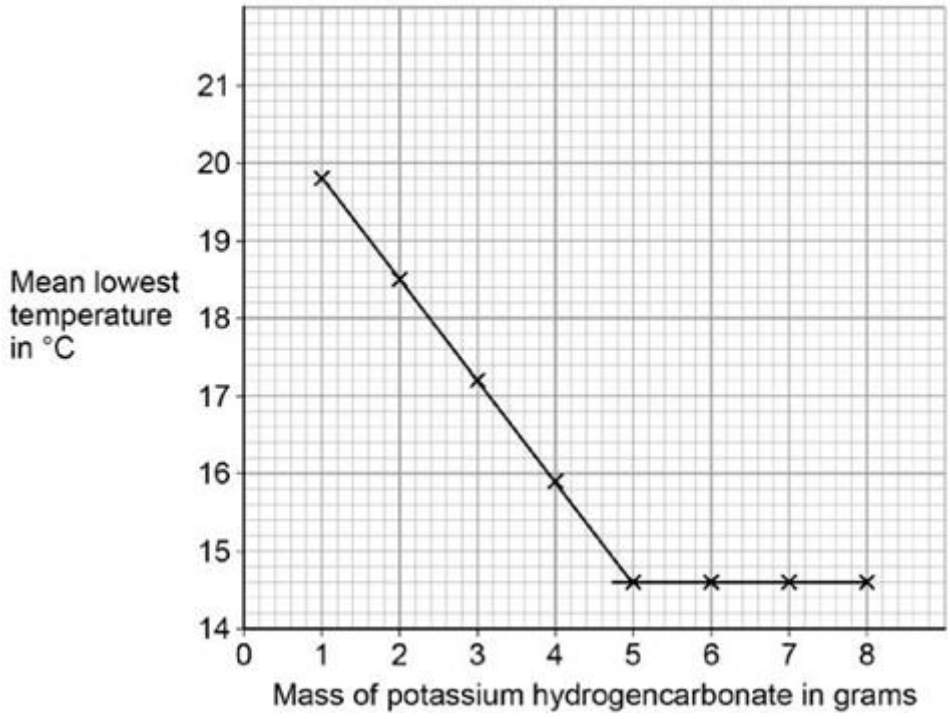
1

horizontal straight line from (5.0, 14.6 to 8.0, 14.6)

ignore continuation of line in either direction

1

the answer below scores **2** marks



(i) (lowest) temperature decreases

1

to 14.6 °C
or
until 5 g added

1

then no change to temperature (after 5 g solid added)
or

then temperature remains at 14.6 °C (after 5 g solid added)

1

[15]

Q5. (a) copper, zinc, sodium chloride solution

1

(b) a reactant is used up

allow the reaction stops

allow electrolyte / electrode / ions / metal / metal hydroxide / alkali for reactant

1

(c) the reaction is not reversible

1

(d) $2H_2 + O_2 \longrightarrow 2H_2O$

allow fractions / multiples

*allow **1** mark for O_2*

2

(e) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

5–6

Level 2: Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. This is not logically linked.

1–2

No relevant content

0

Indicative content

reasons why fuel cells could be judged as better

from the table	**from other knowledge**
• time for refuelling a fuel cell is faster than recharging **or** a fuel cell does not need to be recharged • a fuel cell has a greater range	• hydrogen can be renewable if made by electrolysis using renewable energy • lithium-ion batteries can catch fire • produces only water **or** no pollutants produced • lithium-ion batteries may release toxic chemicals on disposal • lithium-ion batteries

	(eventually cannot be recharged so) have a finite life

reasons why the lithium-ion battery could be judged as better

from the table	**from other knowledge**
• lithium-ion uses energy more efficiently • cost of lithium-ion car much less • cost of recharging much less than refuelling with hydrogen	• hydrogen is often made from fossil fuels so is not renewable • charging points are more widely available than hydrogen filling stations • hydrogen takes up a lot of space **or** is difficult to store • hydrogen can be highly flammable / explosive • no emissions produced • (catalyst in the hydrogen fuel-cell eventually becomes poisoned so) have a finite life

[11]