New Document 1

Name: _____

Class: _____

Date: _____

Time: **45 minutes**

Marks: **45 marks**

Comments:

Q1.

A student investigates a potassium salt, **X**.

She finds that salt **X**:

- has a high melting point
- does not conduct electricity when it is solid
- dissolves in water and the solution does conduct electricity.

(a) What is the type of bonding in salt **X**?

Tick **one** box.

Covalent	☐
Giant molecular	☐
Ionic	☐
Metallic	☐

(1)

(b) What is the name given to solutions that conduct electricity?

_____

(1)

(c) Why does a solution of salt **X** in water conduct electricity?

_____

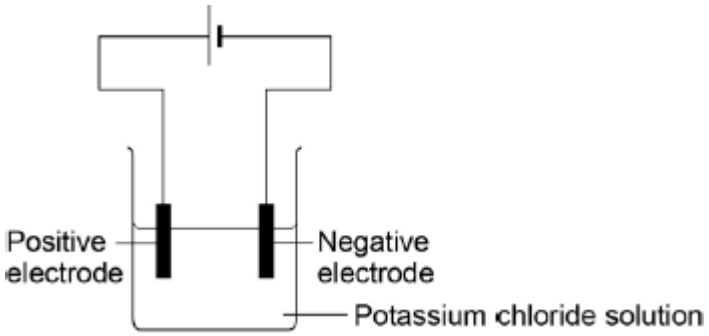
_____

(1)

(d) The student electrolyses a solution of potassium chloride.

Figure 1 shows the apparatus she uses.

Figure 1



When the current is switched on, bubbles of hydrogen gas are given off at the negative electrode.

Explain why hydrogen is produced and **not** potassium.

_____

_____

_____

_____

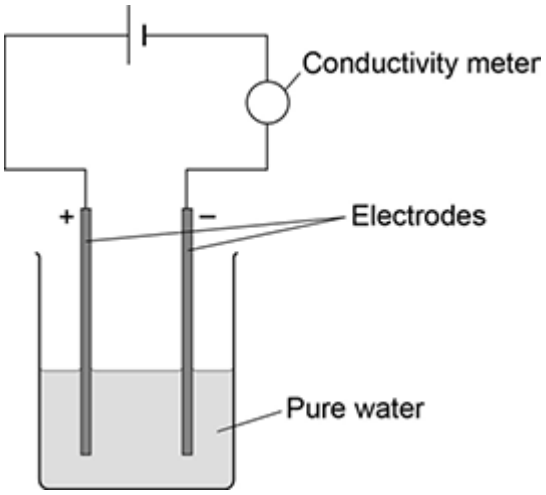
_____

(2)

(e) The student then compares the relative conductivity of different concentrations of potassium chloride.

Figure 2 shows the apparatus she uses.

Figure 2



This is the method used.

1. Add potassium chloride solution to the water one drop at a time.

2. Stir the mixture.

3. Record the reading on the conductivity meter.

The table below shows the student's results.

Number of drops of potassium chloride solution	**Relative conductivity of solution**
0	0
1	90
2	180

3	270
4	360
5	450
6	540

When there is no potassium chloride in the beaker no electrical charge flows.

Suggest why pure water does **not** conduct electricity.

_____

_____

_____

_____

(2)

(f) Describe the relationship shown in the table above.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q2.

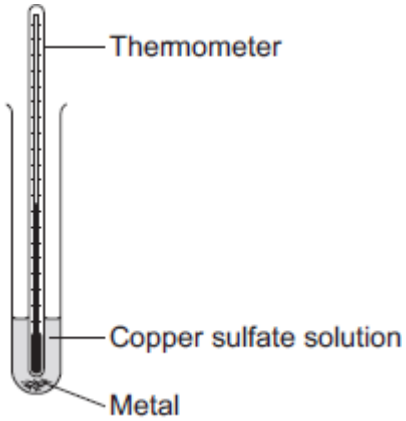
A student investigated displacement reactions of metals.

The student added different metals to copper sulfate solution and measured the temperature change.

The more reactive the metal is compared with copper, the bigger the temperature change.

The apparatus the student used is shown in **Figure 1**.

Figure 1



(a) State **three** variables that the student must control to make his investigation a fair test.

1. _____

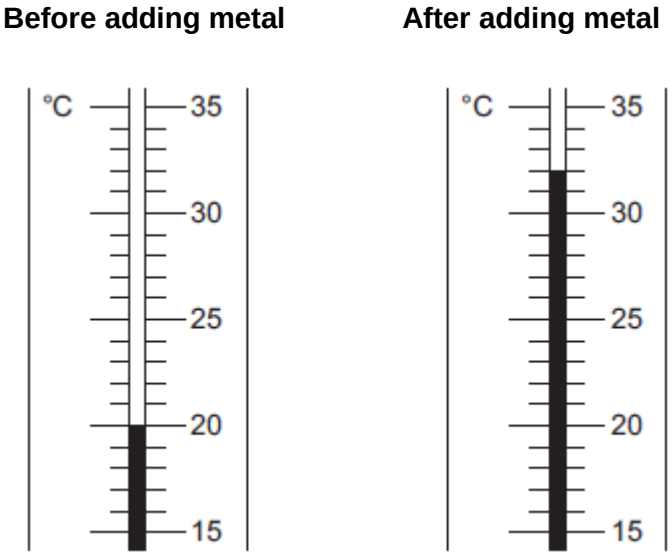
2. _____

3. _____

(3)

(b) **Figure 2** shows the thermometer in one experiment before and after the student added a metal to the copper sulfate solution.

Figure 2



Use **Figure 2** to complete **Table 1**.

Table 1

Temperature before adding metal in °C	_____
Temperature after adding metal in °C	_____
Change in temperature in °C	_____

(3)

(c) The student repeated the experiment three times with each metal.

Table 2 shows the mean temperature change for each metal.

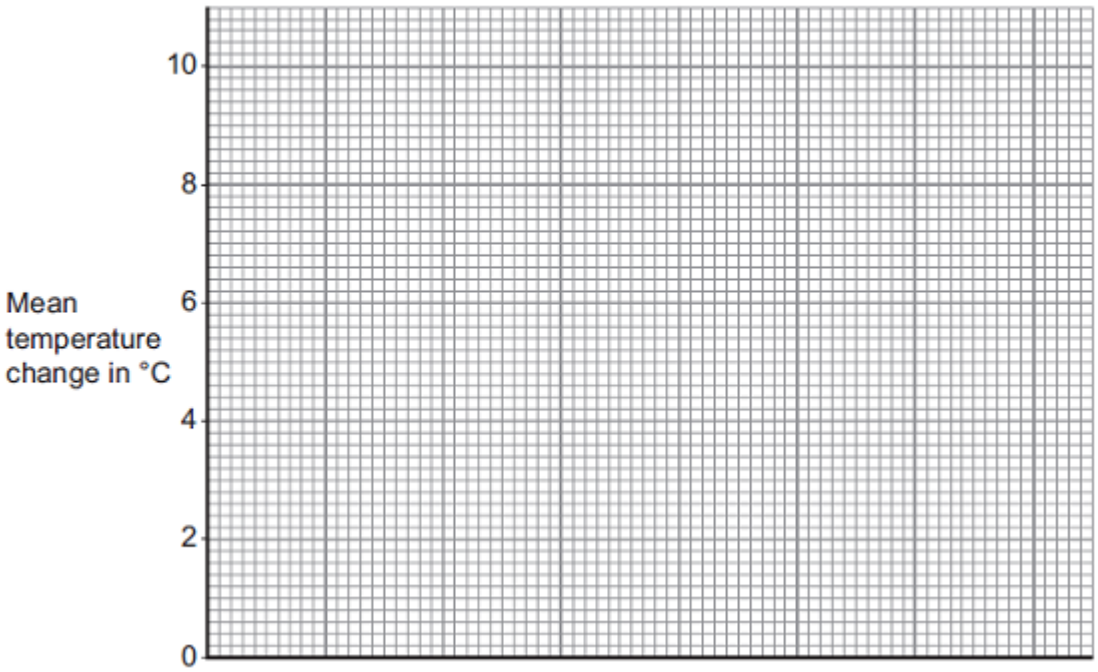
Table 2

Metal	**Mean temperature change in °C**
Cobalt	4.5

Gold	0.0
Magnesium	10.0
Nickel	3.0
Silver	0.0
Tin	1.5

(i) On **Figure 3**, draw a bar chart to show the results.

Figure 3



(3)

(ii) Why is a line graph **not** a suitable way of showing the results?

_____

_____

(1)

(iii) Use the results to work out which metal is the most reactive.

Give a reason for your answer.

Most reactive metal _____

Reason _____

_____

(2)

(iv) Explain why there was no temperature change when silver metal was added to the copper sulfate solution.

_____

_____

_____

_____

(2)

(v) It is **not** possible to put all six metals in order of reactivity using these results.

Suggest how you could change the experiment to be able to put all six metals into order of reactivity.

_____

_____

_____

_____

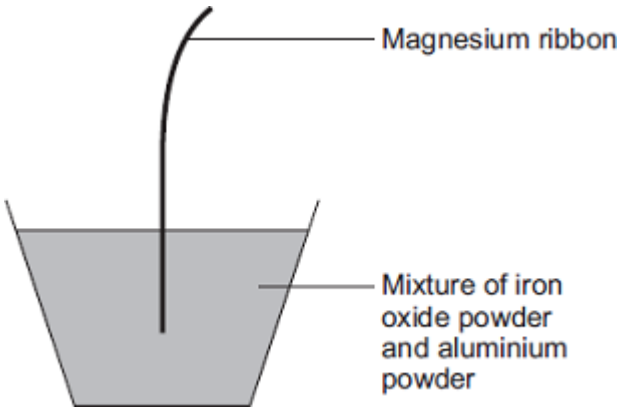
_____

(2)

(Total 16 marks)

Q3.

The diagram shows one way of producing iron.



Iron oxide reacts with aluminium to produce iron.

The symbol equation for the reaction is:

$Fe_2O_3 + 2\ Al \longrightarrow 2\ Fe + Al_2O_3$

(a) (i) Complete the word equation for this reaction.

iron oxide + aluminium $\longrightarrow$ iron + _____

(1)

(ii) The magnesium ribbon is lit to start the reaction.

Why does the burning magnesium ribbon start the reaction?

_____

_____

(1)

(b) In industry, iron is produced in the blast furnace when iron oxide is heated with carbon.

The iron from the blast furnace is called cast iron.

Cast iron contains carbon.

The diagrams show the structure of pure iron and cast iron.

Pure iron Cast iron

Use the diagrams to help you answer the questions.

(i) Draw a ring around the correct answer to complete the sentence.

Pure iron is an element because pure iron

contains only one sort of atom.
is magnetic.
is a metal.

(1)

(ii) Suggest why cast iron is harder than pure iron.

_____

_____

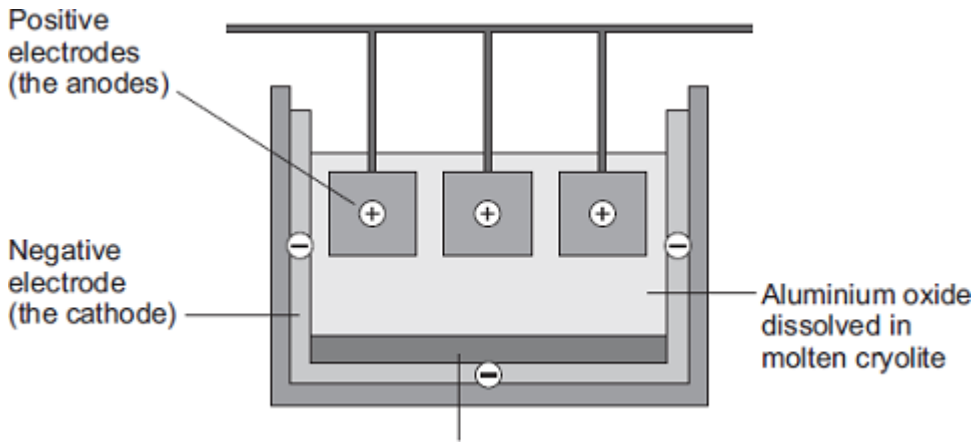
_____

_____

_____

(2)

(c) Aluminium is extracted by electrolysis using the ionic compound aluminium oxide.



Molten aluminium

(i) Aluminium **cannot** be extracted by heating aluminium oxide with carbon.

Suggest why.

_____

_____

(1)

(ii) Why is aluminium oxide dissolved in molten cryolite?

_____

_____

(1)

(iii) Aluminium metal is produced at the negative electrode (cathode).

Complete the half equation for the process.

Al^{3+} + _____ e^- $\longrightarrow$ Al

(1)

(iv) Use the half equation to state why Al^{3+} ions are reduced.

_____

_____

(1)

(v) Explain why the positive electrodes (anodes) burn away.

Use your knowledge of the products of electrolysis to help you.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 13 marks)

Q4.

Limestone is used as a building material. Acid rain erodes limestone.

(a) Limestone contains calcium carbonate.
The symbol equation for the reaction of calcium carbonate with hydrochloric acid is shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Describe a test to show that carbon dioxide is produced in this reaction.

Give the result of the test.

_____

_____

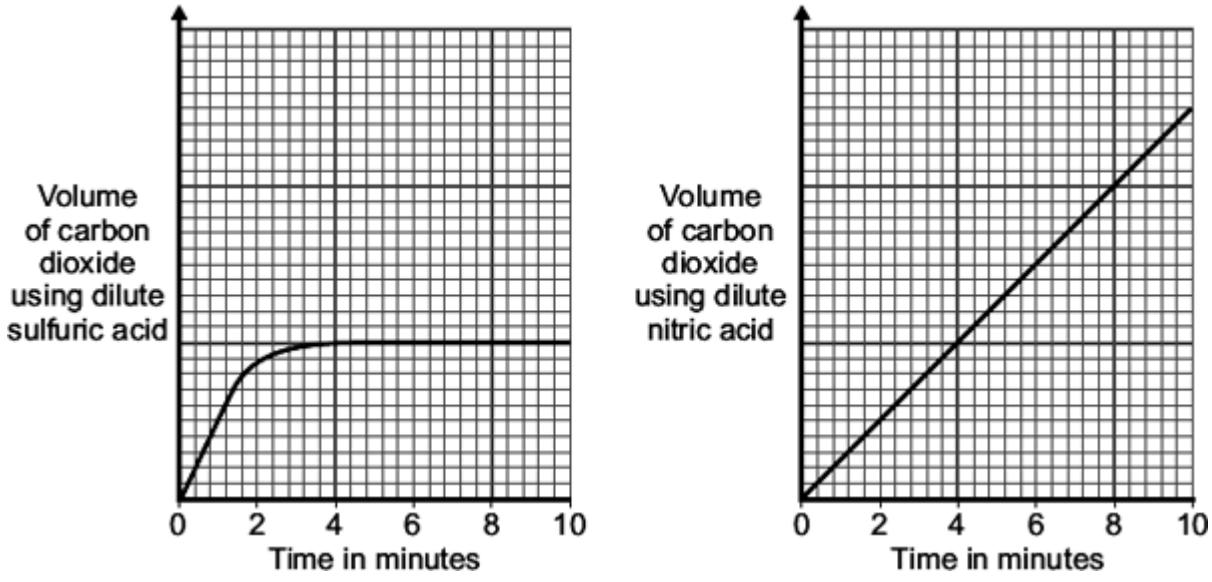
_____

_____

(2)

(b) Gases from vehicle exhausts produce sulfuric acid and nitric acid.

A student investigated the reaction of these two acids with calcium carbonate (limestone).
The type of acid was changed but all other variables were kept the same.
The student measured the volume of carbon dioxide produced each minute for a total of 10 minutes. He did this first for the reaction between dilute sulfuric acid and a cube of calcium carbonate (limestone).
The student repeated the experiment using dilute nitric acid in place of the dilute sulfuric acid.
The results are shown below.



(i) State **two** variables that must be kept the same for this investigation.

_____

_____

_____

_____

(2)

(i) Reacting calcium carbonate with sulfuric acid gave different results to nitric acid.

The symbol equations for the reaction of calcium carbonate with sulfuric acid and with nitric acid are shown below.

$CaCO_3(s) + H_2SO_4(aq) \rightarrow CaSO_4(s) + H_2O(l) + CO_2(g)$

$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$

Describe how the results for sulfuric acid are different **and** use the symbol equations to explain this difference.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Mark schemes

Q1.

(a) Ionic

1

(b) electrolyte

1

(c) because the ions are free to flow

1

(d) because potassium is higher in the reactivity series than hydrogen

1

so it is less easily discharged than hydrogen

1

(e) because water is covalent / molecular / contains molecules

1

so there are no free electrons to move **or** does not have an overall electrical charge

1

(f) conductivity of the solution increases with concentration

1

in a linear relationship **or** directly proportional

1

[9]

Q2.

(a) any **three** from:

- concentration of (salt) solution
- volume of (salt) solution

  ignore amount of solution
- **initial** temperature (of the solution)

  ignore room temperature
- surface area / form of metal
- moles of metal

  allow mass / amount

  ignore time

  ignore size of tube

3

(b) 20

1

32

1

12

allow ecf

1

(c) (i) four bars of correct height

tolerance is + / - half square
*3 correct for **1** mark*

2

bars labelled

1

(ii) *one variable* is non-continuous / categoric
accept qualitative or discrete
accept no values between the metals

1

(iii) magnesium

1

because biggest temperature change
accept gives out most energy
ignore rate of reaction
dependent on first mark

1

(iv) does not react / silver cannot displace copper

1

because silver not more reactive (than copper) **or** silver below copper in reactivity series
*do **not** accept silver is less reactive than copper sulfate*

1

(v) replace the copper sulfate
could be implied

1

with any compound of a named metal less reactive than copper
allow students to score even if use an insoluble salt

1

[16]

Q3.

(a) (i) aluminium oxide
ignore (III) after aluminium

1

(ii) (because it provides) heat / energy (to overcome activation energy)

1

(b) (i) contains only one sort of atom

1

(ii) the atoms (in cast iron) are different sizes
*any mention of molecules, maximum **1** mark*
*accept layers are distorted **or** structure is disrupted*

1

which prevents the <u>layers / rows</u> sliding
accept an answer in terms of pure iron being softer than cast iron for both marks

1

(c) (i) because aluminium is more reactive than carbon

'it' = aluminium must be a comparison between the elements

or

because aluminium is above carbon in the reactivity series

*do **not** accept any comparison of the reactivity of aluminium and iron*

1

(ii) reduces / lowers the temperature for the process **or** lowers the operating temperature **or** allows ions to move

ignore any temperature values

allow reduces the (effective) melting point (of Al_2O_3)

1

(iii) 3

accept multiples

1

(iv) electrons are gained (by Al^{3+})

ignore any numbers

ignore any reference to oxygen

1

(v) electrodes are made of carbon

allow graphite / coke

1

oxygen is produced (at the positive electrode / anode)

accept $2O^{2-} \rightarrow O_2 + 4e^-$

1

so the electrodes react with the oxygen / are oxidised

1

producing carbon dioxide (gas)

accept $C + O_2 \rightarrow CO_2$ for marking points 3 and 4.

1

[13]

Q4.

(a) limewater **or** calcium hydroxide solution

1

(reacts with carbon dioxide and) turns cloudy / milky

linked to first point

*if no other mark awarded 'puts out lighted splint' gains **1** mark*

1

(b) (i) any **two** from:

- same volume / amount of the acids
- concentration of the acids
- temperature

- same surface area / size / mass / amount of calcium carbonate
- same measuring equipment

2

(ii) any **three** from:

- (after about 4 minutes) the sulfuric acid stops reacting **or** nitric acid continues to react
  accept more CO_2 with nitric acid at any time after 4 minutes
- (initially) the reaction with sulfuric acid is faster
- (the reaction stops) because calcium sulfate is a solid
  allow sulfuric acid produces a solid
- (the reaction continues) because calcium nitrate is soluble / in solution / aqueous
  allow nitric acid produces an (aqueous) solution
- because the calcium sulfate prevents the sulfuric acid reacting with the calcium carbonate
- (the rate is faster) because sulfuric acid contains two hydrogens

3

[7]