Chemical Changes 3

Name: _____

Class: _____

Date: _____

Time: **78 minutes**

Marks: **71 marks**

Comments:

1. This question is about metals.

(a) Complete the sentence.

Choose the answer from the box.

compounds	elements	polymers

Most metals are found in the Earth as _____.

(1)

(b) Iron is extracted from iron oxide by reduction with carbon.

Why is iron extracted by reduction with carbon?

Tick (✓) **one** box.

Iron is less reactive than carbon. ☐

Iron has the same reactivity as carbon. ☐

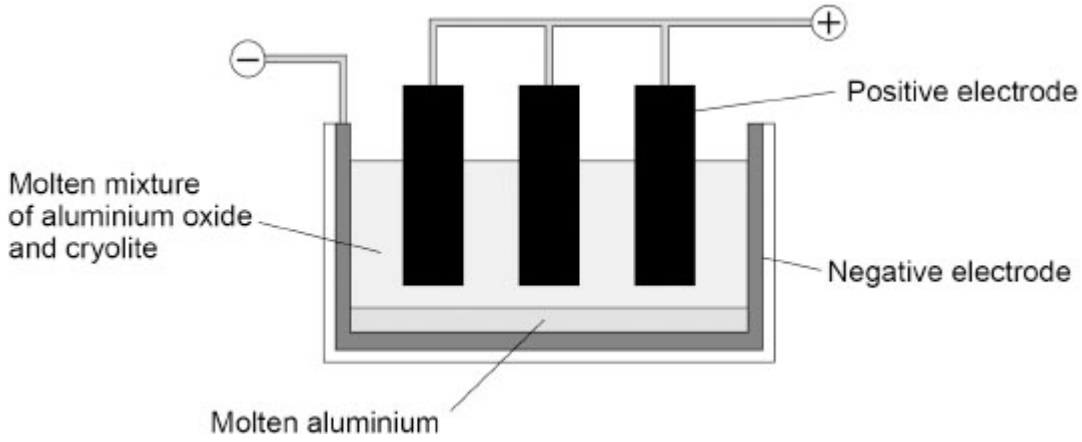
Iron is more reactive than carbon. ☐

(1)

Aluminium is extracted by the electrolysis of aluminium oxide.

Figure 1 shows the apparatus used to extract aluminium.

Figure 1



(c) The mixture of aluminium oxide and cryolite has a lower melting point than aluminium oxide alone.

Why is the melting point lowered?

Tick (✓) **one** box.

To reduce the amount of energy used ☐

To reduce the purity of the aluminium formed ☐

To reduce the rate of reaction ☐

(1)

(d) After some time, the positive electrodes need to be replaced.

Why must the positive electrodes be replaced?

Tick (✓) **one** box.

The electrodes dissolve in the molten mixture. ☐

The electrodes melt in the molten mixture. ☐

The electrodes react with aluminium. ☐

The electrodes react with oxygen gas. ☐

(1)

Aluminium can be mixed with other metals to form alloys.

(e) How does the hardness of an alloy of aluminium compare with the hardness of pure aluminium?

Tick (✓) **one** box.

The alloy is harder than the pure metal. ☐

The alloy and the pure metal have the same hardness. ☐

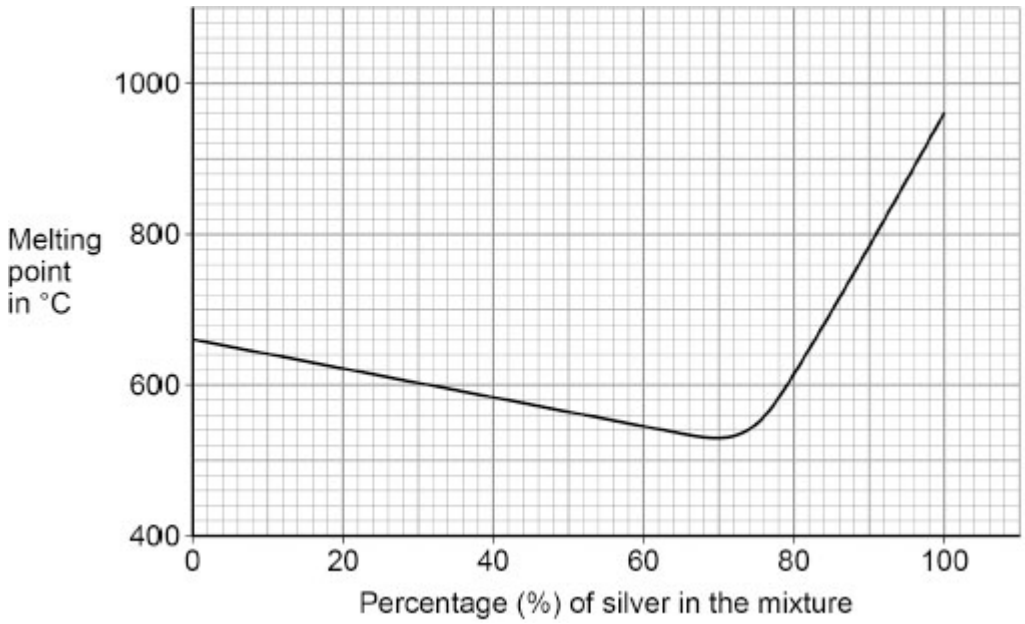
The alloy is less hard than the pure metal. ☐

(1)

(f) Aluminium can form an alloy with silver.

Figure 2 shows how the melting point of the alloy changes with the percentage (%) of silver in the mixture.

Figure 2



Describe how the melting point of the alloy changes as the percentage of silver in the mixture increases.

Use data from **Figure 2**.

_____

_____

_____

_____

_____

_____

(3)

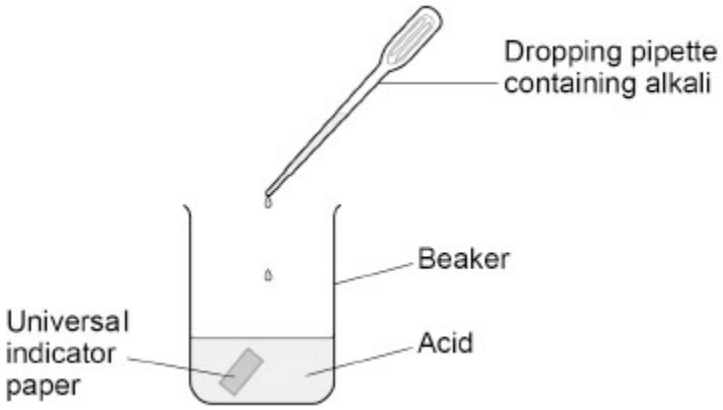
(Total 8 marks)

2. This question is about acids.

A student investigated the volume of an alkali needed to react completely with 25 cm^3 of an acid.

Figure 1 shows the apparatus.

Figure 1



This is the method used.

1. Add 25 cm^3 of the acid to a beaker.

2. Add a piece of universal indicator paper to the acid.

3. Add the alkali drop by drop to the acid until the universal indicator paper changes colour to green.

4. Record the number of drops of alkali added.

(a) The method does **not** give an accurate volume of alkali needed to react completely with the acid.

Suggest **two** improvements to the method.

1 _____

_____

2 _____

_____

(2)

(b) What is the pH of the solution when the universal indicator paper turns green?

Tick (✓) **one** box.

1 ☐ 5 ☐ 7 ☐ 9 ☐

(1)

(c) What name is given to the reaction between an acid and an alkali?

Tick (✓) **one** box.

Combustion ☐

Displacement ☐

Neutralisation ☐

(1)

(d) Which ion do all acids contain?

Tick (✓) **one** box.

Cl^- ☐ H^+ ☐ Na^+ ☐

(1)

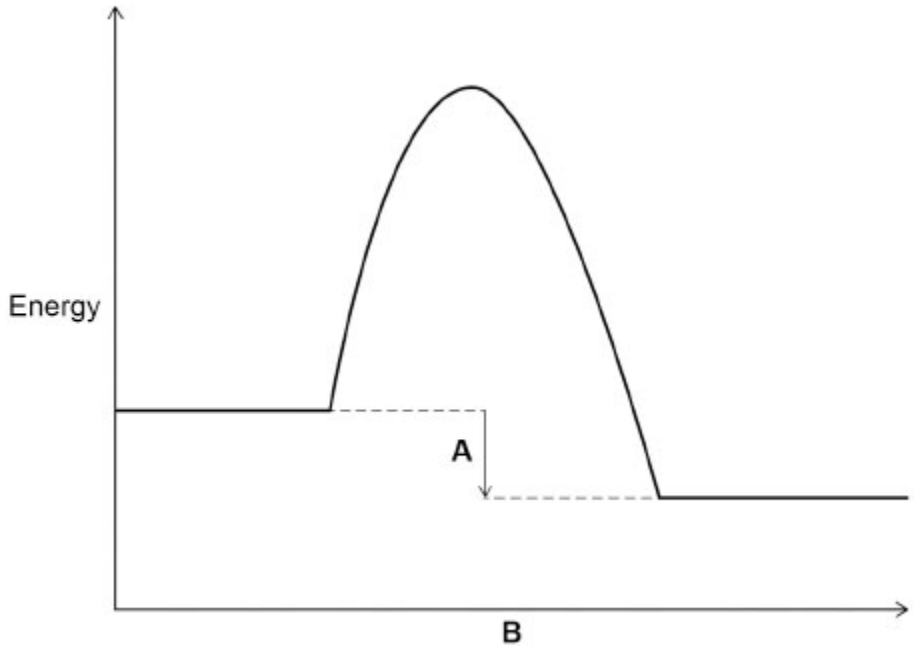
(e) Name the acid that reacts with sodium hydroxide to produce sodium nitrate.

_____

(1)

(f) **Figure 2** shows a reaction profile for the reaction between an acid and an alkali.

Figure 2



What do labels **A** and **B** represent on **Figure 2**?

Choose the answers from the box.

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

A _____

B _____

(2)

Acids also react with insoluble solid substances to produce salt solutions.

(g) When making a salt solution, excess solid is added to the acid.

Draw the apparatus used to separate the excess solid from the salt solution by filtration.

The apparatus should collect:

- the excess solid
- the salt solution.

(2)

(h) Solid **X** reacts with hydrochloric acid to produce zinc chloride and hydrogen gas.

Name solid **X**.

_____

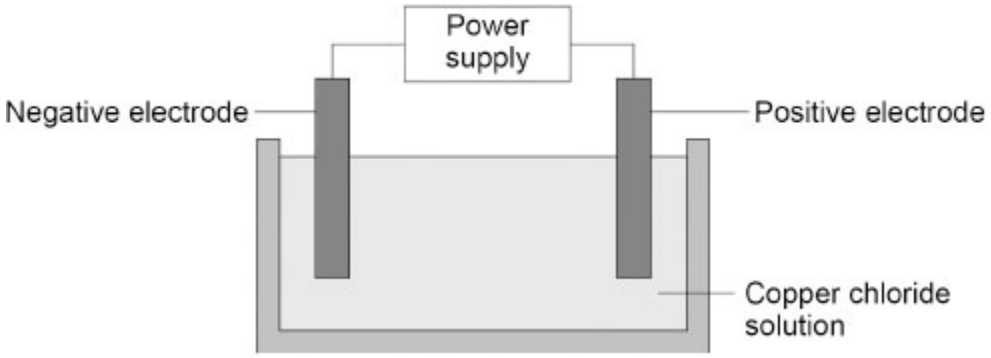
(1)

(Total 11 marks)

3. A teacher demonstrated the electrolysis of copper chloride solution.

Figure 1 shows the apparatus.

Figure 1



The teacher measured the mass of the negative electrode every 60 seconds.

(a) Chlorine gas is given off during the electrolysis of copper chloride solution.

Chlorine gas is poisonous.

Give **one** way of reducing the risk of harm.

_____

_____

(1)

The table below shows the results.

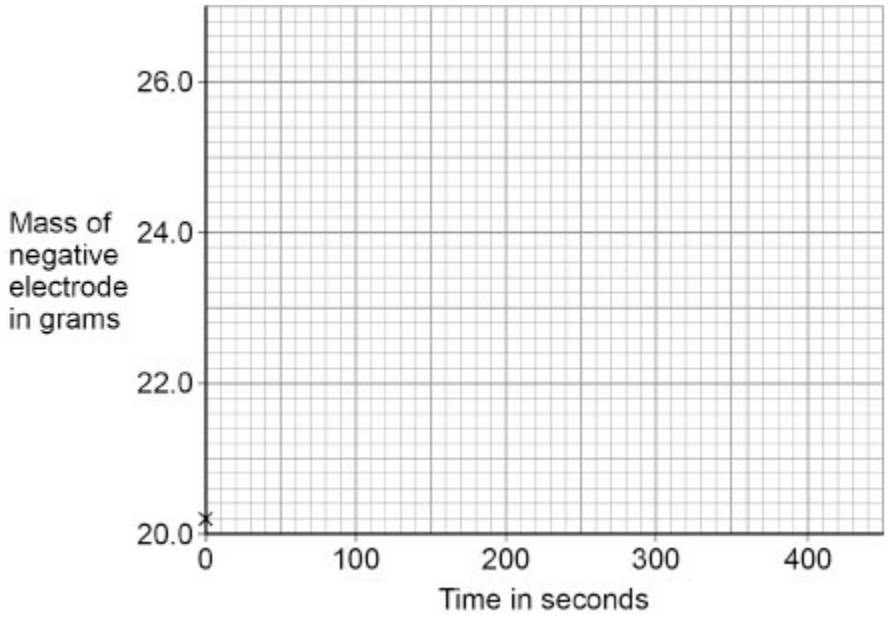
Time in seconds	**Mass of negative electrode in grams**
0	20.2
60	22.0
120	23.4
180	24.2
240	24.8
300	25.2
360	25.2

(b) Plot the data from the table above on **Figure 2**.

Draw a line of best fit.

The first point has been plotted for you.

Figure 2



(3)

(c) A student made the hypothesis:

'The negative electrode will increase by a constant mass every 60 seconds.'

How do the results in the table above show that the hypothesis is **not** correct?

_____

_____

(1)

(d) 25 cm^3 of the solution of copper chloride contained 5.5 g of copper chloride.

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

1 dm^3 = 1000 cm^3

_____

_____

_____

_____

_____

Concentration = _____ g/dm^3

(3)

(e) The teacher also electrolysed potassium chloride solution.

Hydrogen gas was given off at the negative electrode.

Why was hydrogen gas given off?

Tick (✓) **one** box.

Hydrogen is less reactive than potassium. ☐

Hydrogen has the same reactivity as potassium. ☐

Hydrogen is more reactive than potassium. ☐

(1)

(Total 9 marks)

4. In the Earth most metals are found as compounds.

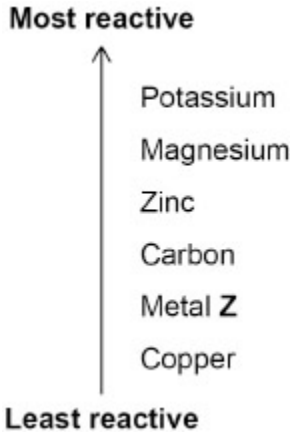
(a) Name **one** metal that is found in the Earth as the metal itself.

_____

(1)

Figure 1 shows a reactivity series.

Figure 1



(b) Suggest the most economical method for extracting metal **Z** from an oxide of metal **Z**.

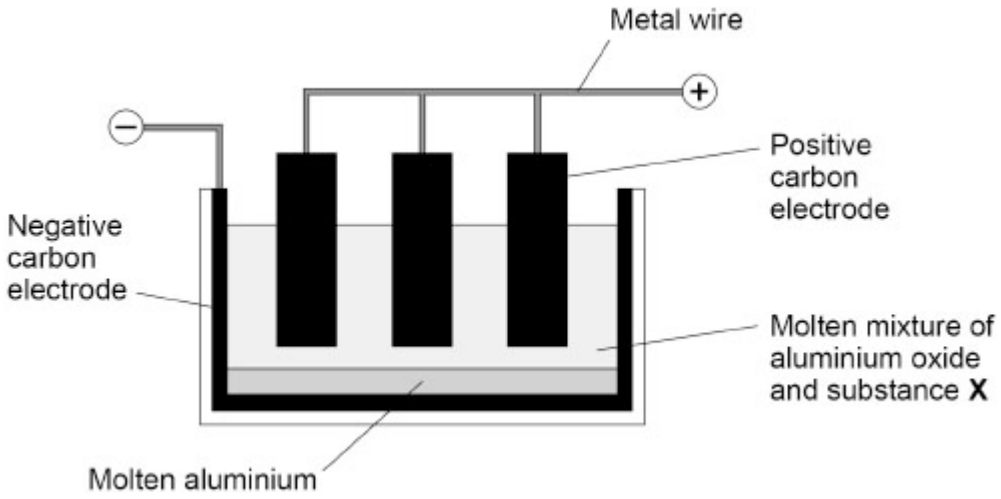
_____

_____

(1)

Figure 2 shows the electrolysis cell used to extract aluminium from aluminium oxide.

Figure 2



(c) Name substance **X** shown in **Figure 2**.

_____

(1)

(d) Explain what happens to the **positive** carbon electrodes during the extraction of aluminium from aluminium oxide.

_____

_____

_____

_____

_____

_____

(3)

(e) The formula of aluminium oxide is Al_2O_3

Write a half equation for the reaction at the **negative** electrode in **Figure 2**.

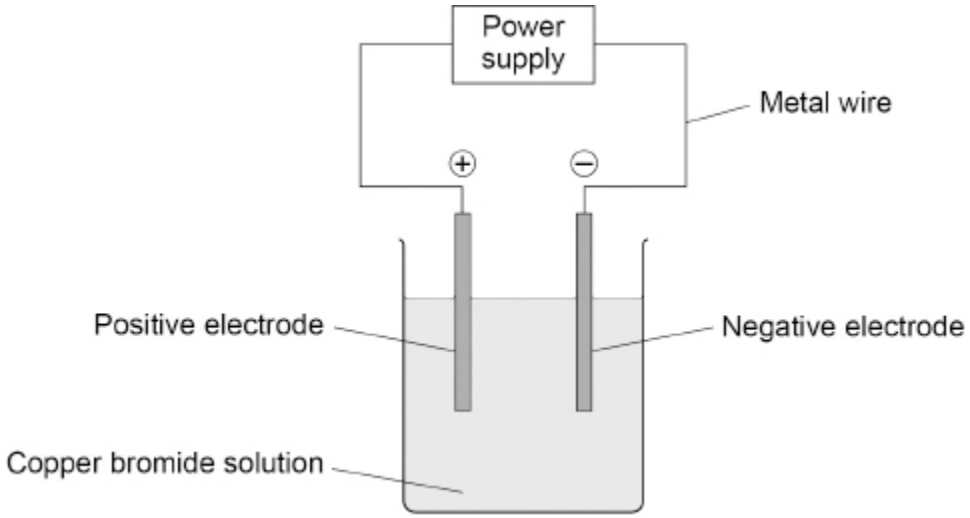
_____ + _____ → _____

(2)

(Total 8 marks)

5. Copper bromide solution is electrolysed using inert electrodes.

The figure below shows the apparatus.



(a) Which particles carry the electrical charge through the metal wire?

Tick (✓) **one** box.

Electrons ☐

Neutrons ☐

Protons ☐

(1)

There are four ions in copper bromide solution:

- Cu^{2+}
- Br^{-}
- H^{+}
- OH^{-}

(b) Two of these ions are formed when a water molecule breaks down.

The symbol equation when a water molecule breaks down is:

$$H_2O \rightarrow H^+ + OH^-$$

Complete the **word** equation for the breakdown of a water molecule.

water → _____ ion + _____ ion

(2)

(c) Copper ions and bromide ions carry the electrical charge through the solution.

The formula of a copper ion is Cu^{2+}

The formula of a bromide ion is Br^-

What is the formula of copper bromide?

Tick (✓) **one** box.

CuBr ☐

Cu_2Br ☐

$CuBr_2$ ☐

(1)

(d) Explain why copper ions (Cu^{2+}) move to the negative electrode.

_____

_____

_____

_____

(2)

(e) Complete the sentence.

Choose the answer from the box.

decomposed	**discharged**	**distilled**

At the negative electrode copper metal is produced when the

copper ions are _____.

(1)

(f) What happens to the mass of the **negative** electrode during electrolysis?

Tick (✓) **one** box.

Decreases ☐

No change ☐

Increases ☐

(1)

There are four ions in copper bromide solution:

- Cu^{2+}
- Br^{-}
- H^{+}
- OH^{-}

(g) What is produced at the **positive** electrode when copper bromide solution is electrolysed?

Tick (✓) **one** box.

Bromine ☐

Hydrogen ☐

Oxygen ☐

(1)

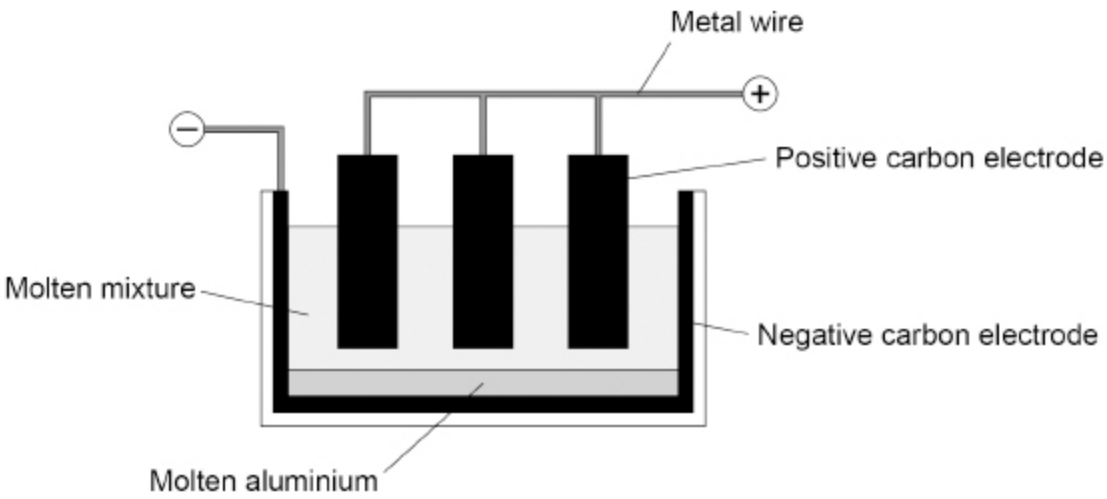
(Total 9 marks)

6. This question is about extraction of metals.

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

Figure 1 shows the electrolysis cell.

Figure 1



(a) Complete the sentence.

The extraction of aluminium is expensive because the process uses large amounts of _____.

(1)

(b) Oxygen is produced at the positive carbon electrodes.

The oxygen reacts with the carbon electrodes.

Which gas is produced when oxygen reacts with the positive carbon electrodes?

_____

(1)

Titanium is extracted from titanium chloride by reacting titanium chloride with sodium.

The reaction between titanium chloride and sodium is carried out in an inert atmosphere.

(c) Suggest why the reaction is carried out in an inert atmosphere.

_____

_____

(1)

(d) Complete the sentence.

Choose the answer from the box.

argon	**chlorine**	**hydrogen**

The gas used for the inert atmosphere is _____.

(1)

(e) Balance the equation for the reaction.

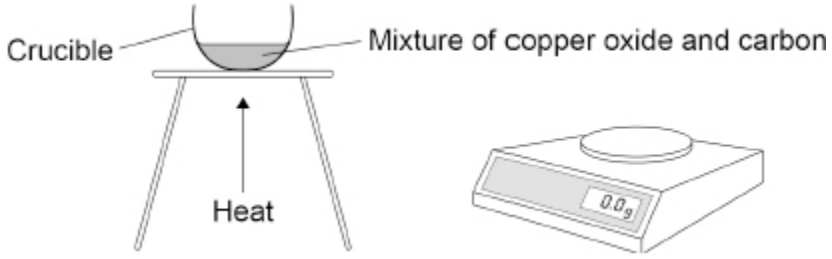
$$TiCl_4 + 4\ Na \rightarrow Ti + \_\_\_\_\_\ NaCl$$

(1)

Copper is extracted from copper oxide by reacting copper oxide with carbon.

Figure 2 shows the apparatus.

Figure 2



The equation for the reaction is:

$$2\ CuO(s) + C(s) \rightarrow 2\ Cu(s) + CO_2(g)$$

In an experiment 15.9 g of copper oxide and 1.2 g of carbon reacted.

12.7 g of copper was produced in the reaction.

(f) Calculate the mass of carbon dioxide produced in this experiment.

_____

_____

Mass of carbon dioxide = _____ g

(1)

(g) Explain why the mass of the contents in the crucible changed during the experiment.

_____

_____

_____

_____

(2)

(h) What happens to copper oxide in the reaction?

Give **one** reason for your answer.

Use the equation for the reaction.

Tick (✓) **one** box.

The copper oxide is dissolved	☐
The copper oxide is oxidised	☐
The copper oxide is reduced	☐

Reason _____

_____

(2)

(Total 10 marks)

7. Acids react with some metals to produce soluble salts**.**

A student adds magnesium to hydrochloric acid until no more acid reacts and excess magnesium remains.

The equation for the reaction is:

$$Mg(s) + 2\ HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

(a) Describe how solid magnesium chloride is obtained from the reaction mixture.

_____

_____

_____

_____

(2)

(b) The reaction between magnesium and hydrochloric acid is a redox reaction.

Explain what happens to the magnesium atoms in this reaction.

_____

_____

_____

_____

(2)

(c) 0.72 g of magnesium is added to 100 cm^3 of hydrochloric acid.

The hydrochloric acid is in excess.

Calculate the concentration of the magnesium chloride ($MgCl_2$) solution produced in g/dm^3.

Relative atomic mass (A_r): Mg = 24

Relative formula mass (M_r): $MgCl_2$ = 95

Concentration = _____ g/dm^3

(6)

(Total 10 marks)

8. Plan an investigation to find the order of reactivity of three metals.

You should use the temperature change when each metal reacts with hydrochloric acid.

(Total 6 marks)

1. (a) compounds

1

(b) iron is less reactive than carbon

1

(c) to reduce the amount of energy used

1

(d) the electrodes react with oxygen gas

1

(e) the alloy is harder than the pure metal

1

(f) (melting point of alloy) decreases

1

until 70% (silver)

allow a value in the range 69% to 71%

1

or

until 530 °C

allow a value in the range 520 °C to 540 °C

then (melting point) increases

*if no other mark awarded, allow **1** mark for*

(melting point) increases from 660 °C to 960 °C

or

(melting point) increases by 300 °C

1

[8]

2. (a) any **two** from:

- measure the volume of the alkali

  ignore references to safety

  allow use a measuring cylinder (to measure the alkali)

  allow use a burette (to measure the alkali)
- repeat **and** calculate a mean
- stir / swirl the mixture
- use universal indicator solution

  allow use a pH probe

2

(b) 7

1

(c) neutralisation

1

(d) H^+

1

(e) nitric (acid)

allow HNO_3

1

(f) (**A**) overall energy change

1

(**B**) progress of reaction

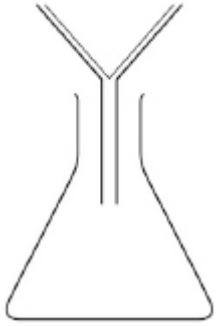
1

(g) filter funnel with filter paper inside

1

a container to collect the filtrate

an answer of



*scores **2** marks*

1

(h) zinc

allow Zn

1

[11]

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

- do experiment in a fume cupboard

  ignore references to safety glasses or gloves

  allow use an extractor fan

- do experiment in a well-ventilated laboratory / room

  allow descriptions of well-ventilated such as open windows

  allow use a gas mask

1

(b) all 6 points plotted correctly

allow a tolerance of ± ½ a small square

*allow **1** mark for 4 or 5 points plotted correctly*

2

line of best fit

1

(c) any **one** from:

- the increase in mass (for successive 60 second intervals) decreases

  allow evidence of two correctly determined changes in mass (for 60 second intervals) from the table

  allow the difference in mass (every 60 seconds) is not the same
- after 300 seconds the mass remains constant

1

(d) (volume conversion 25 cm^3 =)
0.025 (dm^3)

1

(concentration =) $\frac{5.5}{0.025}$

allow correct use of an incorrect / no conversion of volume

1

= 220 (g/dm^3)

OR

(concentration =) $\frac{5.5}{25}$ (1)

= 0.22 (g/cm^3) (1)

(conversion = 0.22 × 1000) = 220 (g/dm^3) (1)

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

using the values in the question

OR

(ratio of volume $\frac{1000}{25}$ =) 40 (1)

(so ratio of mass =) 40 × 5.5 (1)

= 220 (g/dm^3) (1)

1

(e) hydrogen is less reactive than potassium

1

[9]

4. (a) gold

allow Au
allow silver / Ag
allow platinum / Pt
allow copper / Cu

1

(b) reduction by carbon

allow heating / reacting with carbon

1

(c) cryolite

1

(d) oxygen is produced

1

(which) reacts with the carbon / electrode / anode to form carbon dioxide

1

(so the electrode) has to be continually replaced

allow (so) the electrode is used up
allow (so) the electrode burns away

1

(e) $Al^{3+} + 3\ e^- \rightarrow Al$

allow **1** mark for
$Al^{3+} + e^- \rightarrow Al$
with no / incorrect balancing numbers

2

[8]

5. (a) electrons

1

(b) (water →) hydrogen (ion) + hydroxide (ion)

*allow for **1** mark hydrogen (ion)*
*allow for **1** mark hydroxide (ion)*

2

(c) $CuBr_2$

1

(d) (copper ions) are positive(ly charged)

1

(so are) attracted (to the negative electrode)

1

(e) discharged

1

(f) increases

1

(g) bromine

1

[9]

6. (a) energy / electricity

1

(b) carbon dioxide

1

(c) sodium reacts with air / oxygen
or
sodium is highly reactive

allow titanium (chloride) reacts with air / oxygen

1

(d) argon

1

(e) $TiCl_4 + 4\ Na \rightarrow Ti + \mathbf{4}\ NaCl$

allow multiples

1

(f) 4.4 (g)

1

(g) (the) mass decreased

1

(because) carbon dioxide escapes (into the atmosphere)

allow (because) carbon dioxide is a gas

allow (because) a gas is produced

1

(h) the copper oxide is reduced

1

(reason)
(copper oxide) loses oxygen

1

[10]

7. (a) filter (to remove excess magnesium)

1

(then) crystallisation (of magnesium chloride solution)

allow (then) evaporation (of water from magnesium chloride solution)

1

(b) (magnesium atoms are) oxidised

1

(because the atoms) lose (two) electrons

1

(c) (moles Mg =) $\frac{0.72}{24}$

1

= 0.03

1

(moles Mg = moles $MgCl_2$)
(so mass $MgCl_2$ =) 0.03 × 95

allow a correct calculation using an incorrectly calculated value of moles of magnesium

allow a correct calculation using an incorrectly calculated value of moles of magnesium chloride

1

= 2.85 (g)

1

(100.0 cm^3 = 0.100 dm^3

concentration = $\frac{\text{mass}}{\text{volume}}$)

= $\frac{2.85}{0.100}$

allow correct use of incorrectly calculated mass of magnesium chloride

1

= 28.5 (g/dm^3)

1

[10]

8. **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

- measure volume (hydrochloric) acid
- into a suitable container eg polystyrene cup
- measure the initial temperature (of hydrochloric acid)
- with a thermometer
- add stated mass of one metal
- stir

- measure the highest temperature reached of the solution
  or
  measure temperature reached after a set time period
- determine the temperature difference

- repeat

- repeat for each metal
- with same mass
- in same physical state (powder, lump, etc)
- with the same volume and / or concentration of (hydrochloric) acid

- use results to arrange metals in order of reactivity
- most reactive metal has the largest temperature change

to access level 3 there must be an indication of how the temperature change is determined with the same mass of the 3 different metals reacted with the same volume of (hydrochloric) acid

[6]