C4: Chemical Changes 1

ANSWER KEY

9.1	What is the reactivity series?	A list of elements ordered by their reactivity
9.2	How can metals be placed in order of their reactivity?	Add the metals to water or acid and see which ones react the most vigorously
9.3	**What is the name for a reaction where oxygen is added to a substance?**	**Oxidation**
9.4	**What is the name for a reaction where oxygen is removed from a substance?**	**Reduction**
9.5	Why are metals like gold and platinum found in the Earth's crust as pure metals?	They are unreactive
9.6	**What process is used to extract metals less reactive than carbon?**	**Heating with carbon (reduction)**
9.7	**What process is used to extract metals more reactive than carbon?**	**Electrolysis**
9.8	What is an ore?	A rock containing enough metal in it for it to be economically worthwhile to extract the metal
9.9	What is a displacement reaction?	A reaction in which a more reactive element takes the place of a less reactive element in one of its compounds or in solution
9.10	**(HT) Define oxidation in terms of electrons**	**Oxidation is the loss of electrons (OIL)**
9.11	**(HT) Define reduction in terms of electrons**	**Reduction is the gain of electrons (RIG)**
9.12	Define acid in terms of pH	A substance with a pH of less than 7
9.13	**Which ions are present in all acids?**	**H^+ ions**
9.14	State the three common acids and give their formulae	• Hydrochloric acid, HCl • Sulfuric acid, H_2SO_4 • Nitric acid, HNO_3
9.15	Which ions do the common acids form in solution?	• HCl forms H^+ and Cl^- • H_2SO_4 forms 2 H^+ and SO_4^{2-} • HNO_3 forms H^+ and NO_3^-
9.16	What is neutral solution?	A solution with a pH of 7 e.g. pure water

C4: Chemical Changes 2

ANSWER KEY

10.1	How do you measure pH?	With universal indicator or a pH probe
10.2	**What colour would universal indicator be in:** **a) a strong acid** **b) a neutral substance** **c) a strong alkali**	**a) Red** **b) Green** **c) Purple (or blue)**
10.3	What is base?	A metal oxide, hydroxide or carbonate that will react with (neutralise) acids. e.g. copper oxide
10.4	What is an alkali?	A soluble base. e.g. sodium hydroxide
10.5	**Which ions are always present in a solution of an alkali?**	**OH^- (hydroxide ions)**
10.6	What is a salt?	A compound formed when an acid is neutralised
10.7	**What type of salts are formed by the three main acids?**	• **Hydrochloric acid → metal chloride** • **Sulfuric acid → metal sulfate** • **Nitric acid → metal nitrate**
10.8	What is a neutralisation reaction?	A reaction involving an acid and a base that results in a neutral solution
10.9	**Which ions always react together in a neutralisation reactions between acids and alkalis?**	**H^+ and OH^-**
10.10	**Write the equation showing the reaction between H^+ and OH^- ions**	**$H^+ + OH^- \rightarrow H_2O$**
10.11	Complete the equation: metal + acid →	→ salt + hydrogen
10.12	Complete the equation: metal hydroxide + acid →	→ salt + water
10.13	Complete the equation: metal oxide + acid →	→ salt + water
10.14	Complete the equation: metal carbonate + acid →	→ salt + water + carbon dioxide

C4: Chemical Changes 3

ANSWER KEY

11.1	**How do you ensure that all the acid is neutralised when making a salt?**	**Use excess base**
11.2	**How do you remove the excess base?**	**Filter it**
11.3	**How do you make salt crystals from the salt solution?**	**Heat the solution in an evaporating dish, then leave rest of the water to evaporate slowly**
11.4	**(HT) What is a strong acid?**	**An acid which completely dissociates (breaks up) into H^+ ions in water** **e.g. when HCl is in water all the HCl molecules split up into H^+ and Cl^-**
11.5	**(HT) What is a weak acid?**	**An acid which only partially dissociates (breaks up) into H^+ ions in water** **e.g. in ethanoic acid only some of the molecules will have split up into the ethanoate ion and H^+ ions**
11.6	(HT) What is the relationship between the strength of an acid and its pH?	Stronger acids have lower pH numbers (more acidic)
11.7	What is a concentrated acid?	An acid where there are lots of acid particles in a fixed volume of water
11.8	What is a dilute acid?	An acid where there are fewer acid particles in a fixed volume of water
11.9	**(HT) How does pH depend on the concentration of H^+ ions in a solution?**	**As the concentration of H^+ increases by a factor of ten, the pH decreases by one (more acidic)**
11.10	What is electrolysis?	Using electricity to produce elements by splitting up an ionic compound
11.11	**Why does electrolysis only work with molten or aqueous ionic compounds?**	**So the ions are free to move (to the electrodes) and carry charge**
11.12	What is the name for the positive electrode?	Anode
11.13	What is the name for the negative electrode?	Cathode
11.14	**Why do positive ions move to the cathode? And negative ions move to the anode?**	**They are oppositely charged (opposites attract)**

C4: Chemical Changes 4

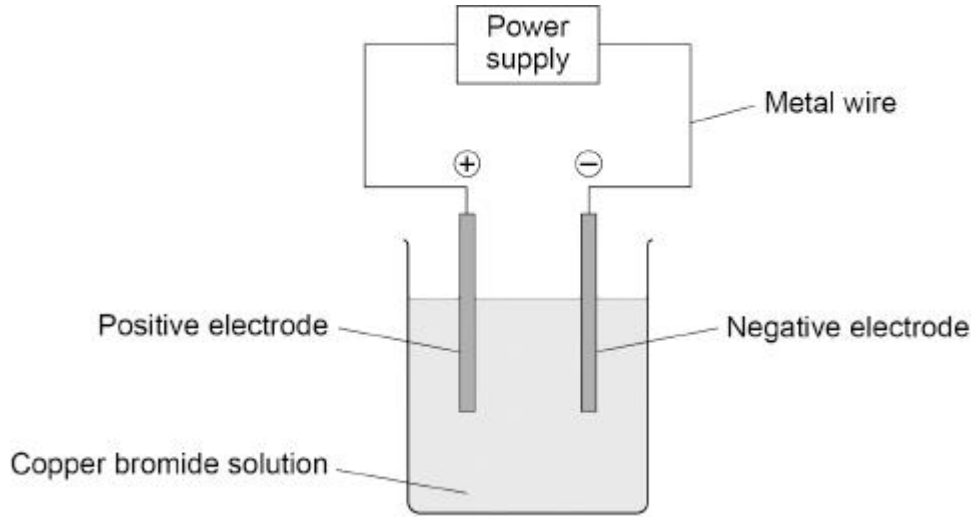
ANSWER KEY

12.1	What are the electrodes usually made from?	Graphite (as it conducts electricity)
12.2	What is the main disadvantage of using electrolysis to extract metals?	Requires a large amount of energy to a) melt the compounds b) to produce the necessary electricity
12.3	**Why is aluminium oxide dissolved in cryolite when extracting aluminium?**	**To lower the melting point**
12.4	What is produced at the anode and cathode in the electrolysis of aluminium oxide?	Aluminium at the cathode and oxygen at the anode
12.5	**Why do the graphite anodes need regularly replacing in the electrolysis of aluminium oxide?**	• **They are made from carbon** • **which reacts with the oxygen** • **forming carbon dioxide** • **so they burn away**
12.6	In electrolysis of molten ionic compounds, where is the metal produced?	Cathode (negative electrode)
12.7	In electrolysis of molten ionic compounds, where is the non-metal produced?	Anode (positive electrode)
12.8	What can happen to water molecules in the electrolysis of solutions?	They break down into hydrogen and hydroxide ions (H^+ and OH^-)
12.9	**In the electrolysis of an aqueous ionic solution, when will hydrogen be produced?**	**If the metal is more reactive than hydrogen**
12.10	**In the electrolysis of an aqueous ionic solution, when will oxygen be produced?**	**If the non-metal is not a halogen (group 7 element)**
12.11	(HT) Complete the half equations: Al^{3+} → Al $\_\_H^+$ → H_2 $\_\_O^{2-}$ → O_2 $\_\_OH^-$ → O_2 + $\_\_H_2O$	 $Al^{3+} + 3e^- \rightarrow Al$ $2H^+ + 2e^- \rightarrow H_2$ $2O^{2-} - 4e^- \rightarrow O_2$ $4OH^- - 4e^- \rightarrow O_2 + 2H_2O$

FOUNDATION TIER

Q1. 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)

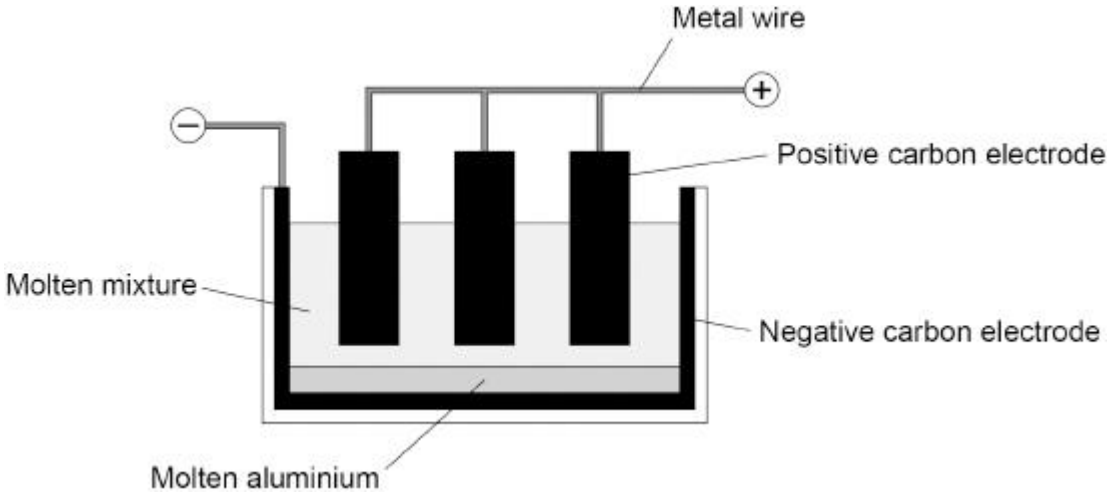
(Total 9 marks)

Q2. 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.

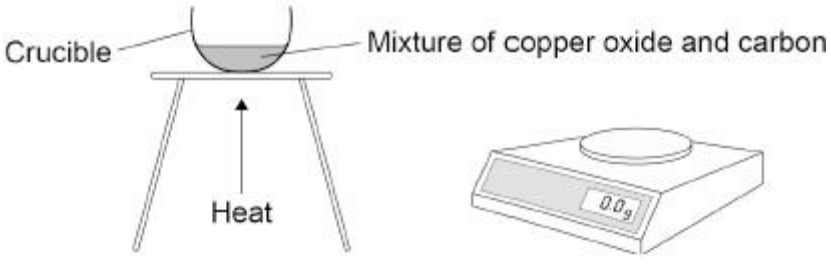
$$TiCl_4 + 4\ Na \rightarrow Ti + \_\_\_\_\_\ NaCl$$

(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)

Q3. A student investigated the temperature change when metal **X** was added to copper sulfate solution. This is the method used.

1. Add 25 cm^3 of copper sulfate solution to a beaker.
2. Measure the temperature of the copper sulfate solution.
3. Add 1.0 g of metal **X** and stir.
4. Measure the highest temperature reached when metal **X** is added to copper sulfate solution.
5. Repeat steps 1 to 4 with different metals.

Figure 1 shows the apparatus used.

Figure 1

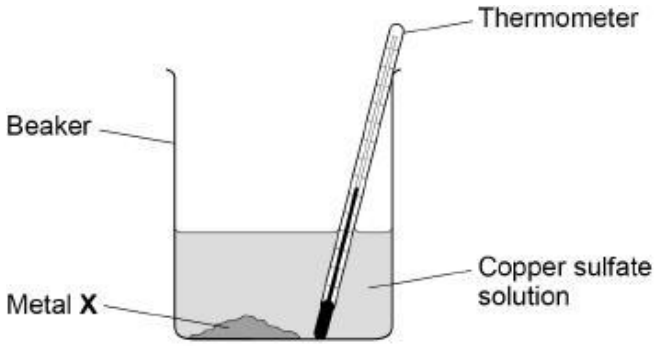
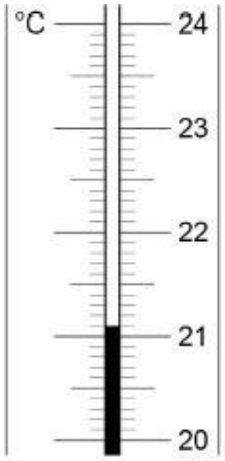


Figure 2 shows the thermometer reading of the copper sulfate solution at the start of the investigation.

Figure 2



(a) The highest temperature reached when metal **X** was added to copper sulfate solution was 35.5 °C

Determine the temperature change when metal **X** is added to copper sulfate solution.

Use **Figure 2**.

Highest temperature = 35.5 °C

Temperature at start = _____ °C

Temperature change = _____ °C

(2)

(b) Give **two** variables the student should keep the same in this investigation.

1. _____

_____

2. _____

_____

(2)

(c) The student repeated the experiment with metal **Y**.

Table 1 shows four results for metal **Y**.

Table 1

	Test 1	**Test 2**	**Test 3**	**Test 4**
Temperature change in °C	9.2	7.3	9.5	9.2

Calculate the mean temperature change for metal **Y**.

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

_____

_____

_____

_____

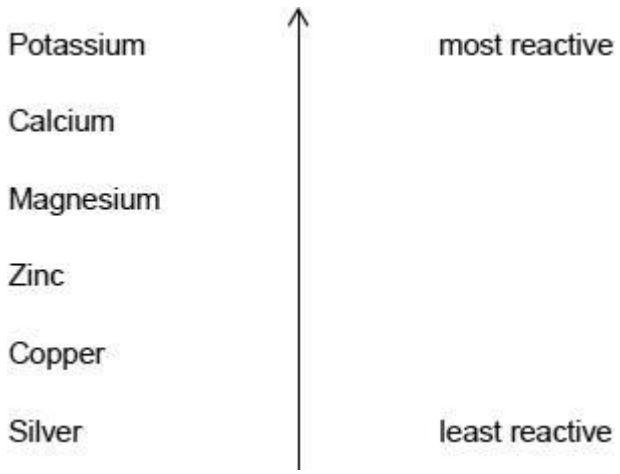
Mean temperature change = _____ °C

(2)

The more reactive the metal added to copper sulfate solution, the greater the temperature change.

Figure 3 shows a reactivity series.

Figure 3



(d) The student repeated the experiment.

The student added:

- magnesium to copper sulfate solution
- an unknown metal **A** to copper sulfate solution.

Table 2 shows the results.

Table 2

Metal	**Temperature change in °C**
Magnesium	12
Metal **A**	8

The student concludes metal **A** is zinc.

Give **one** reason why the student is correct.

Use **Figure 3** and **Table 2**.

_____

_____

(1)

(e) The student did the experiment with silver and copper sulfate solution.

What happens to the temperature of the mixture?

Use **Figure 3**.

Tick (✓) **one** box.

Decreases	☐
Increases	☐
Stays the same	☐

(1)

(f) Suggest **one** reason why the student should **not** add potassium metal to copper sulfate solution.

_____

_____

(1)

(g) 100 cm^3 of the copper sulfate solution contains 1.8 g of copper sulfate.

Calculate the mass of copper sulfate in 25 cm^3 of this copper sulfate solution.

_____

_____

_____

_____

Mass = _____ g

(2)

(Total 11 marks)

Q4. Acids react to produce salts. Universal indicator is added to water and then nitric acid is added to the mixture.

(a) Give the colour change when acid is added to the mixture of universal indicator and water.

Tick (✓) **one** box.

Blue to red ☐

Green to purple ☐

Green to red ☐

Red to purple ☐

(1)

(b) What happens to the pH of water when nitric acid is added? Tick (✓) **one** box.

Decreases ☐

Stays the same ☐

Increases ☐

(1)

(c) What is the state symbol for nitric acid?

_____

(1)

Zinc carbonate reacts with nitric acid. The word equation for the reaction is:

zinc carbonate + nitric acid → zinc nitrate + water + carbon dioxide

white solid — colourless solution

(d) Give **two** observations that would be made when zinc carbonate is added to nitric acid until the zinc carbonate is in excess.

1 _____

_____

2 _____

_____

(2)

(e) The formula of the zinc ion is Zn^{2+}

The formula of the nitrate ion is NO_3^-

What is the formula for zinc nitrate?

Tick (✓) **one** box.

$ZnNO_3$ ☐

$Zn(NO_3)_2$ ☐

Zn_2NO_3 ☐

$Zn_2(NO_3)_2$ ☐

(1)

(f) Acids react with insoluble metal oxides to produce salts.

Plan a method to produce a pure, dry sample of the soluble salt copper chloride from an acid and a metal oxide.

(6)

(Total 12 marks)

HIGHER TIER

Q5. This question is about the extraction of aluminium.

(a) An aluminium atom is represented as:

$$^{27}_{13}Al$$

Give the number of electrons and neutrons in the aluminium atom.

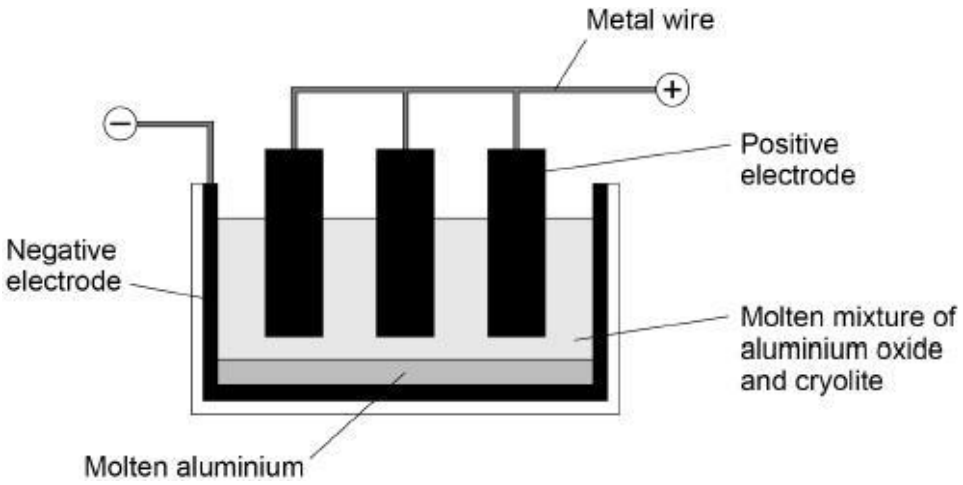
Number of electrons _____

Number of neutrons _____

(2)

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

The diagram below shows the cell used for the electrolysis.



(b) Aluminium is produced by the reduction of aluminium oxide (Al_2O_3).

What is meant by the term reduction?

_____

_____

(1)

(c) Oxygen is formed at the positive carbon electrodes.

Explain why the positive carbon electrodes must be continually replaced.

_____

_____

_____

_____

(3)

(d) A substance conducts electricity because of free moving, charged particles.

What are the free moving, charged particles in a:

- carbon electrode (made from graphite)
- molten mixture of aluminium oxide and cryolite
- metal wire?

Carbon electrode (made from graphite) _____

Molten mixture of aluminium oxide and cryolite _____

Metal wire _____

(3)

(Total 9 marks)

Q6. This question is about magnesium and magnesium chloride.

(a) Magnesium chloride contains magnesium ions (Mg^{2+}) and chloride ions (Cl^-).

Describe, in terms of electrons, what happens when a magnesium atom reacts with chlorine atoms to produce magnesium chloride.

_____

_____

_____

_____

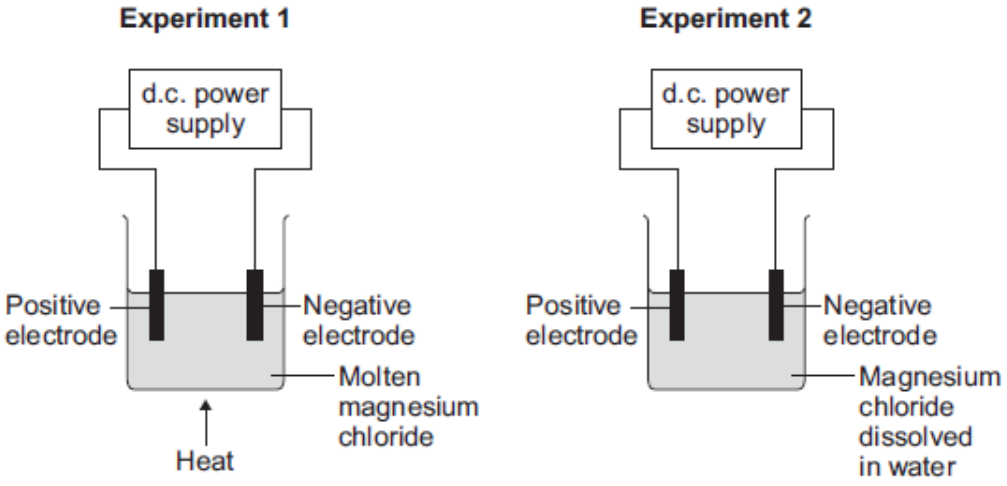
_____

_____

(4)

(b) Magnesium chloride can be electrolysed.

The diagram below shows two experiments for electrolysing magnesium chloride.



(i) Explain why magnesium chloride must be molten or dissolved in water to be electrolysed.

_____

_____

_____

(2)

(ii) Explain how magnesium is produced at the negative electrode in **Experiment 1**.

_____

_____

_____

_____

_____

(3)

(iii) In **Experiment 2** a gas is produced at the negative electrode.
Name the gas produced at the negative electrode.

_____

(1)

(iv) Suggest why magnesium is **not** produced at the negative electrode in **Experiment 2**.

_____

_____

(1)

(v) Complete and balance the half equation for the reaction at the positive electrode.

_____ Cl^- $\longrightarrow$ Cl_2 + _____

(1)

(c) Magnesium is a metal.

Explain why metals can be bent and shaped.

_____

_____

_____

_____

(2)

(Total 14 marks)

Q7. This question is about the electrolysis of aqueous solutions.

Hydrogen gas and chlorine gas are produced when sodium chloride solution is electrolysed.

(a) Hydrogen ions (H^+) are attracted to the negative electrode.

The half equation for the reaction at the negative electrode is:

$$2\ H^+ \quad + \quad 2\ e^- \quad \rightarrow \quad H_2$$

What type of reaction happens at the negative electrode?

Give the reason for your answer.

Type of reaction _____

Reason _____

_____

(2)

(b) Chloride ions are attracted to the positive electrode.

Complete the half equation for the production of chlorine gas (Cl_2).

$$\_\_\_\ Cl^- \quad \rightarrow \_\_\_\_\_ + \_\_\_\_\_$$

(2)

(c) Hydrogen gas and oxygen gas are produced when sodium sulfate solution is electrolysed.

Explain how oxygen gas is produced in the electrolysis of sodium sulfate solution.

_____

_____

_____

_____

_____

_____

_____

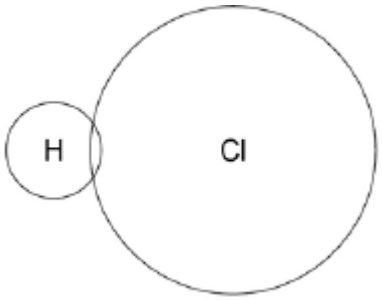
_____

(4)

(Total 8 marks)

Q8. Hydrogen chloride (HCl) is a gas.

(a) Complete the diagram to show all of the arrangement of the outer shell electrons of the hydrogen and chlorine atoms in hydrogen chloride.



(1)

(b) Hydrochloric acid is a strong acid.
Ethanoic acid is a weak acid.

Describe a reaction that could be used to show the difference between a weak acid and a strong acid.

You should explain why the weak acid and the strong acid give different results.

(6)
(Total 7 marks)

SEPARATE SCIENCE

Q9. This question is about acids and alkalis.

(a) Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

_____

_____

_____

(2)

(b) A 1.0×10^{-3} mol/dm^3 solution of hydrochloric acid has a pH of 3.0

What is the pH of a 1.0×10^{-5} mol/dm^3 solution of hydrochloric acid?

pH = _____

(1)

A student titrated 25.0 cm^3 portions of dilute sulfuric acid with a 0.105 mol/dm^3 sodium hydroxide solution.

(c) The table below shows the student's results.

	Titration 1	**Titration 2**	**Titration 3**	**Titration 4**	**Titration 5**
Volume of sodium hydroxide solution in cm^3	23.50	21.10	22.10	22.15	22.15

The equation for the reaction is:

$$2\ NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2\ H_2O$$

Calculate the concentration of the sulfuric acid in mol/dm^3

Use only the student's concordant results. Concordant results are those within 0.10 cm^3 of each other.

_____

_____

_____

_____

_____

_____

Concentration of sulfuric acid = _____ mol/dm^3

(5)

(d) Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

_____

_____

_____

_____

(2)

(e) Calculate the mass of sodium hydroxide in 30.0 cm^3 of a 0.105 mol/dm^3 solution.

Relative formula mass (M_r): NaOH = 40

_____

_____

_____

_____

Mass of sodium hydroxide = _____ g

(2)

(Total 12 marks)

Q1.

(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]

Q2.

(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]

Q3.

(a) 21.1 (°C)

1

14.4 (°C)

allow correct use of an incorrect start temperature

1

(b) any **two** from:

- surface area of metal
- 25 cm^3 / volume of copper sulfate solution
- concentration of copper sulfate solution
- mass / 1 g of metal

ignore amount
ignore temperature
ignore stirring

2

(c) $\frac{9.2 + 9.5 + 9.2}{3}$ or $\frac{27.9}{3}$

1

= 9.3 (°C)

*if no other mark awarded allow **1** mark for 8.8 (°C)*

1

(d) (metal **A** / zinc) is less reactive (than magnesium)
or
(metal **A** / zinc) is lower in reactivity series
or
change in temperature is lower (with metal **A** / zinc)

allow converse

1

(e) stays the same

1

(f) too dangerous
or

too reactive

allow potassium would react with water

1

(g) $\frac{25}{100} \times 1.8$ **or** $\frac{1}{4} \times 1.8$

1

= 0.45 (g)

1

[11]

Q4.

(a) green to red

1

(b) decreases

1

(c) (aq)

allow aq
ignore aqueous
ignore HNO_3

1

(d) any **two** from:

- (white) solid disappears
- fizzing **or** bubbles (of gas) **or** effervescence
  allow a gas is produced
- (then) stops fizzing
- (white) solid left at the end / bottom
  ignore colourless solution

2

(e) $Zn(NO_3)_2$

1

(f) **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:

- react hydrochloric acid
- (with) copper oxide
- in a suitable container
- warm (hydrochloric) acid
- add copper oxide
- until is in excess
  or
  until solid remains
- stir
- filter excess copper oxide
- pour solution / filtrate into evaporating basin
- use of water bath
  or
  use of electric heater
- to heat gently
  or
  partially evaporate
- leave to cool / crystallise

For level 3 the correct chemicals must have been selected.

[12]

Q5.

(a)

this order only

13

1

14

1

(b) loss of oxygen

allow (Al^{3+}) gain of electrons
allow aluminium oxide loses oxygen

1

(c)

allow anode for (positive) electrode

(at high temperature) oxygen reacts with carbon / electrode

1

(so the positive) electrode burns / wears away

1

to produce carbon dioxide

$C + O_2 \rightarrow CO_2$ scores MP1 and MP3

1

(d) (delocalised) electron(s)

1

ion(s)

1

(delocalised) electron(s)

1

[9]

Q6.

(a) magnesium loses two electrons **and** chlorine gains one electron

*accept magnesium loses electrons **and** chlorine gains electrons for 1 mark*

ignore oxidation and reduction

2

one magnesium and two chlorines

accept $MgCl_2$

1

noble gas structure

or

eight electrons in the outer shell

accept full outer shell (of electrons)

or

(electrostatic) attraction between ions

or

forms ionic bonds

*do **not** accept covalent bonds*

1

*reference to incorrect particles **or** incorrect bonding **or** incorrect structure = **max 3***

(b) (i) because ions can move

ignore ions attracted

*do **not** accept molecules / atoms moving*

*do **not** accept incorrect reference to electrons moving*

1

(and ions move) to the electrodes

or

(and ions) carry charge

1

accept converse for solid

(ii) magnesium (ions) attracted (to the electrode)

1

so magnesium ions gain electrons

accept magnesium ions are reduced

ignore oxidised

1

2 electrons

*accept a correct half equation for 2nd **and** 3rd marking points*

1

(iii) hydrogen

allow H_2

1

(iv) magnesium is more reactive than hydrogen

accept converse

*allow magnesium is high in the reactivity series **or** magnesium is very/too reactive.*

*do **not** accept magnesium ions are more reactive than hydrogen ions*

1

(v) **2** $Cl^- \rightarrow Cl_2 + \mathbf{2e^-}$

must be completely correct

1

(c) layers (of particles/atoms/ions)

1

(particles/atoms/ions/layers) can slide

1

*any mention of intermolecular / weak bonds/forces = **max 1***

[14]

Q7.

(a) reduction

ignore electrolysis

1

(as H^+ ions) gain electrons

1

(b) $2\ Cl^- \rightarrow Cl_2 + 2\ e^-$

allow $2\ Cl^- - 2\ e^- \rightarrow Cl_2$

ignore state symbols

*allow **1** mark for $Cl_2 + e^-$*

*allow **1** mark for $- e^-$ (on lhs) **and** Cl_2 (on rhs)*

2

(c) water molecules

1

break down to produce OH^- ions

allow dissociate to produce OH^- ions

1

(which are) attracted to the positive electrode

1

(where OH^- ions are) oxidised
or
(where OH^- ions) lose electrons

ignore discharged

ignore oxygen is produced as no halide is present

1

[8]

Q8.

(a) bonded pair of electrons and

6 non-bonded electrons on chlorine

1

(b) **Level 3 (5–6 marks):**
A detailed and coherent explanation of comparative results of a reaction in terms of concentration and ionisation. The response makes logical links between the points raised and uses sufficient examples to support these links.

Level 2 (3–4 marks):
A description of a reaction with results is given but may miss some details. Links are made but may not be fully articulated and / or precise.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content

Indicative content

Simple statements / descriptions of a reaction

- correct comparative pH, such as, 0–3 (strong) 4–6 (weak)
- named reaction, such as, with a reactive metal or a named carbonate
- comparative results or observations of the named reaction, such as, faster reaction (strong) or greater volume of gas produced in a given time (strong)

Explanations of different results

- weak acids are only partially ionised in aqueous solution
- strong acids are completely ionised in aqueous solution / greater concentration of H^+ ions
- aqueous solutions of acids at the same concentration / same state of division
  of metal / powder, same temperature

6

[7]

Q9.

(a) (strong because) completely ionised (in aqueous solution)

ignore pH

allow dissociated for ionised

*do **not** accept hydrogen is ionising*
*do **not** accept H^+ are ionised*

1

(dilute because) small amount of acid per unit volume

ignore low concentration

1

(b) 5.0

allow 5

1

(c) (titre):
chooses titrations 3, 4, 5

1

average titre = 22.13 (cm^3)

allow average titre = 22.13(3…) (cm^3)
allow a correctly calculated average from an incorrect choice of titrations

1

(calculation):
(moles NaOH =
$\frac{22.13}{1000} \times 0.105 = 0.002324$)

allow use of incorrect average titre from step 2

1

(moles H_2SO_4 =
½ × 0.002324 =) 0.001162

allow use of incorrect number of moles from step 3

1

(concentration =
$\frac{0.001162}{25} \times 1000$)
= 0.0465 (mol/dm^3)

allow use of incorrect number of moles from step 4

1

alternative approach for step 3, step 4 and step 5

$\frac{2}{1} = \frac{22.13 \times 0.105}{25.0 \times conc.\ H_2SO_4}$ *(1)*

(concentration H_2SO_4 =)
$\frac{22.13 \times 0.105}{25.0 \times 2}$

= 0.0465 (mol/dm^3) (1)

an answer of 0.046473 ***or*** *0.04648 correctly rounded to at least 2 sig figs scores marking points 3, 4 and 5*

an answer of 0.092946 ***or*** *0.09296* ***or*** *0.185892* ***or*** *0.18592 correctly rounded to at least 2 sig figs scores marking points 3 and 5*

an incorrect answer for one step does ***not*** *prevent allocation of marks for subsequent steps*

(d) pipette measures a fixed volume (accurately)

1

(but) burette measures variable volume

allow can measure drop by drop

1

(e) $(\text{moles} =) \frac{30}{1000} \times 0.105$

or 0.00315 (mol)

or

(mass per dm^3 =) 0.105 × 40

or 4.2 (g)

1

$(\text{mass} = \frac{30}{1000} \times 0.105 \times 40)$

= 0.126 (g)

1

an answer of 0.126 (g) scores ***2*** *marks*

an answer of 126(g) scores ***1*** *mark*

an incorrect answer for one step does ***not*** *prevent allocation of marks for subsequent steps*

[12]