# Combined Science Higher Past Paper Practice

## 5.4 Chemical Changes

| 5.4.1 Reactions of Acids | | | |
|---|---|---|---|
| **Demand** | **Question** | **Page Number** | **Mark Scheme** |
| Low | **1** | 2 | 50 |
| | **5** | 15 | 54 |
| Standard | **7** | 21 | 57 |
| | **10** | 27 | 61 |
| High | **13** | 34 | 65 |
| | **18** | 47 | 73 |

| 5.4.2 Reactions of Metals | | | |
|---|---|---|---|
| **Demand** | **Question** | **Page Number** | **Mark Scheme** |
| Low | **2** | 5 | 51 |
| | **3** | 9 | 52 |
| | **4** | 12 | 53 |
| Standard | **9** | 25 | 59 |
| | **12** | 33 | 64 |
| High | **15** | 39 | 67 |
| | **17** | 45 | 71 |

| 5.4.3 Electrolysis | | | |
|---|---|---|---|
| **Demand** | **Question** | **Page Number** | **Mark Scheme** |
| Low | **3** | 9 | 52 |
| Standard | **6** | 18 | 55 |
| | **8** | 23 | 58 |
| | **11** | 30 | 63 |
| High | **14** | 36 | 66 |
| | **16** | 42 | 69 |

## Q1.

This question is about acids and bases.

(a) What is the pH of sulfuric acid?

Tick (✓) **one** box.

1 ☐ 7 ☐ 14 ☐

**(1)**

(b) An acid reacts with zinc to produce zinc chloride and hydrogen.

Which acid reacts with zinc to produce zinc chloride?

Tick (✓) **one** box.

Hydrochloric acid ☐

Nitric acid ☐

Sulfuric acid ☐

**(1)**

(c) What type of substance is zinc chloride?

Tick (✓) **one** box.

Alkali ☐ Base ☐ Salt ☐

**(1)**

(d) An alkali is a base in solution.

Which compound is an alkali?

Tick (✓) **one** box.

Sodium hydroxide ☐

Sodium nitrate ☐

Sodium sulfate ☐

**(1)**

(e) The formula of the copper ion is $Cu^{2+}$

The formula of the oxide ion is $O^{2-}$

What is the formula of copper oxide?

Tick (✓) **one** box.

$Cu_2O_2$ ☐ $CuO_2$ ☐ CuO ☐

**(1)**

A student reacts an acid with copper oxide.

(f) The reaction between the acid and copper oxide is very slow at room temperature.

How could the student speed up the reaction?

_____

_____

**(1)**

(g) Complete the sentence to show how the student makes sure that **all** the acid reacts.

Choose the answer from the box.

| **in excess** | **in solution** | **molten** | **soluble** |
|---|---|---|---|

The student adds copper oxide to the acid until the

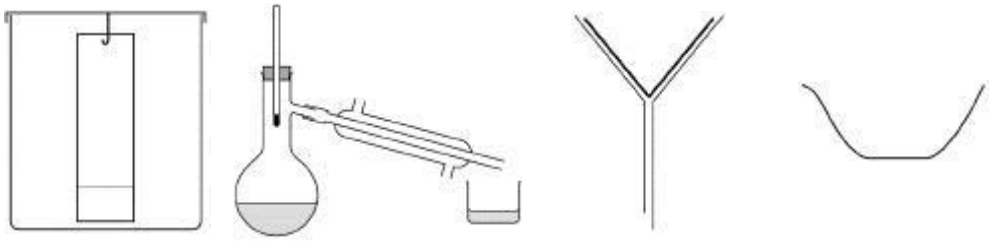
copper oxide is _____.

**(1)**

(h) The student filters the unreacted copper oxide from the solution.

Which apparatus does the student use?

Tick (✓) **one** box.



☐ ☐ ☐ ☐

**(1)**

(i) What process is used to produce crystals of a salt from a salt solution?

_____

_____

**(1)**

**(Total 9 marks)**

## Q2.

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**

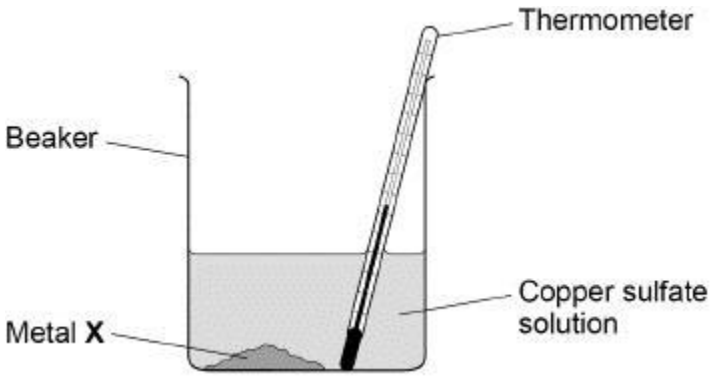
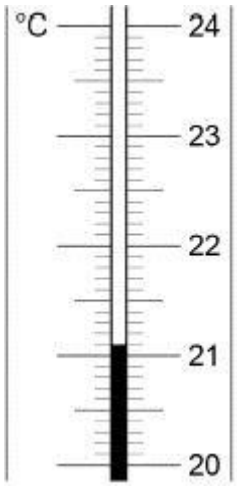



**Figure 2** shows the thermometer reading of the copper sulfate solution at the start of the investigation.

**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.

_____

_____

_____

_____

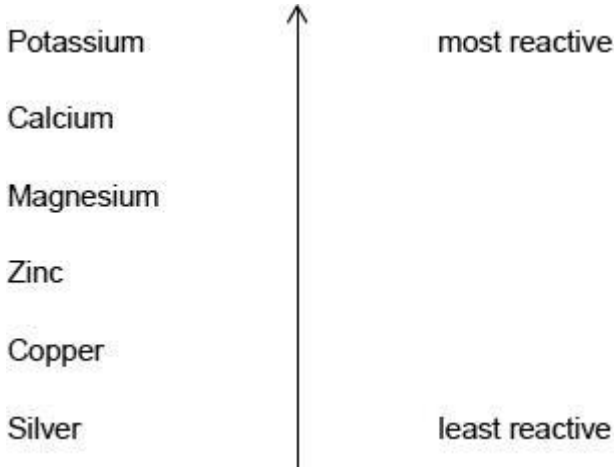
Mean temperature change = _____ °C

**(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)**

## Q3.

This question is about salts and electrolysis.

A student wants to make copper chloride crystals.

The student adds excess copper oxide to some hot acid.

The student stirs the mixture.

(a) Which acid should the student use?

Tick (✓) **one** box.

Hydrochloric acid ☐

Nitric acid ☐

Sulfuric acid ☐

**(1)**

(b) Suggest how the student would know that excess copper oxide has been added.

_____

_____

**(1)**

(c) There are four more stages, **A**, **B**, **C** and **D**, to make copper chloride crystals.

The stages **A**, **B**, **C** and **D** are not in the correct order.

| | |
|---|---|
| Stage **A** | Partially evaporate by heating with a water bath |
| Stage **B** | Filter the mixture into an evaporating basin |
| Stage **C** | Leave to crystallise |
| Stage **D** | Remove and dry the crystals |

Put stages **A**, **B**, **C** and **D** in the correct order.

First stage _____

Second stage _____

Third stage _____

Fourth stage _____

**(2)**

(d) Molten copper chloride can be electrolysed.

State the product at each electrode when molten copper chloride is electrolysed.

Negative electrode _____

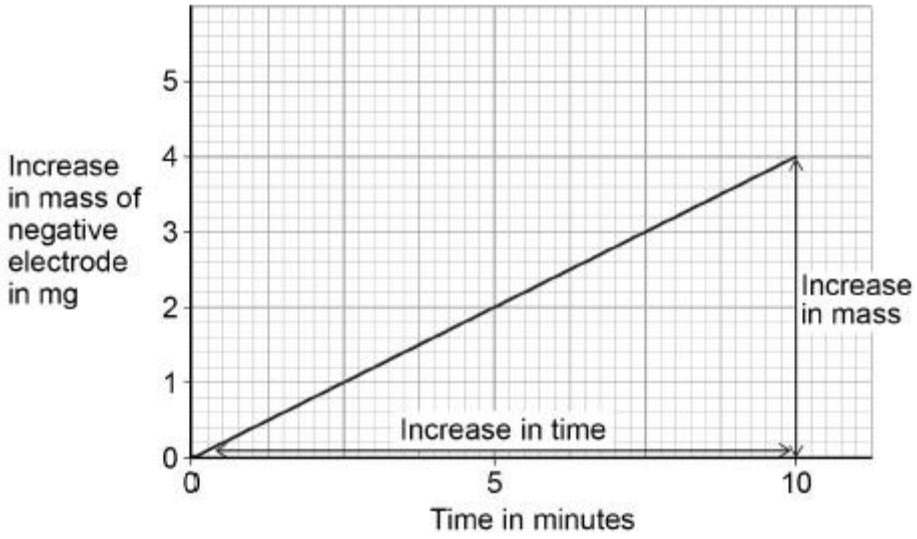
Positive electrode _____

**(2)**

(e) A solution of copper chloride is electrolysed.

The graph below shows the increase in mass of the negative electrode.

This increase is shown over a time of 10 minutes.




Calculate the gradient of the line in the graph.

Use the equation:

$$\text{Gradient} = \frac{\text{increase in mass in mg}}{\text{increase in time in minutes}}$$

Increase in mass _____

_____

Increase in time _____

_____

Gradient _____

_____

_____

_____

Gradient = _____ mg per minute

**(3)**

(f) Aluminium is produced by electrolysis of a molten mixture.

Complete the sentence.

Choose the answers from the box.

| | | | | |
|---|---|---|---|---|
| **carbon** | **chloride** | **cryolite** | **oxide** | **sulfate** |
| | | **water** | | |

The molten mixture contains _____ and

aluminium _____ .

**(2)**

**(Total 11 marks)**

## Q4.

This question is about copper sulfate.

(a) The formula of copper sulfate is $CuSO_4$

The table below shows information about the atoms in copper sulfate.

Complete the table.

| **Element** | **Symbol** | **Relative number of atoms in $CuSO_4$** |
|---|---|---|
| | Cu | |
| Sulfur | | |
| | | 4 |

**(3)**

Copper oxide and sulfuric acid react to produce copper sulfate and water.

(b) Complete the word equation for this reaction.

_____ + _____ → _____ + water

**(1)**

(c) What type of substance is copper oxide?

Tick (✓) **one** box.

A base ☐

A metal ☐

A salt ☐

An acid ☐

**(1)**

A student planned to make blue copper sulfate crystals.

This is the method the student used.

1. Add 25 $cm^3$ of dilute sulfuric acid to a conical flask.

2. Gently warm the dilute sulfuric acid.

3. Add 2 g of black copper oxide to the dilute sulfuric acid.

4. Stir the mixture.

5. Evaporate some of the water from the mixture using an electric heater.

6. Leave the mixture to cool.

Not all the copper oxide reacted. The student did not remove the excess copper oxide.

(d) What would the product look like after step 6?

Tick (✓) **one** box.

Black powder only ☐

Blue crystals and black powder ☐

Blue crystals only ☐

Blue solution only ☐

**(1)**

(e) The student should have filtered the mixture after step 4.

Draw a diagram of the apparatus the student could use.

You should label:

- the pieces of equipment used
- where the excess copper oxide collects.

**(3)**

(f) What equipment should the student use to measure:

- 2 g of copper oxide
- 25 $cm^3$ of dilute sulfuric acid?

Draw **one** line from each measurement to the most suitable piece of equipment.

| Measurement | Equipment |
|---|---|
| | Balance |
| 2 g of copper oxide | Beaker |
| | Measuring cylinder |
| 25 $cm^3$ of dilute sulfuric acid | Metre rule |
| | Thermometer |

**(2)**

(g) 1 g of copper sulfate is dissolved in water to make 25 $cm^3$ of copper sulfate solution.

Calculate the concentration of the copper sulfate solution in $g/dm^3$

_____

_____

_____

Concentration = _____ $g/dm^3$

**(2)**

**(Total 13 marks)**

## Q5.

The following table shows the mass of each ingredient in an indigestion tablet.

| Ingredient | Mass in milligrams |
|---|---|
| Calcium carbonate | 522 |
| Magnesium carbonate | 68 |
| Sodium hydrogencarbonate | 64 |
| Other substances | 146 |

(a) Calculate the mass of the indigestion tablet in grams.

_____

_____

Mass of tablet in milligrams = _____

Mass of tablet in grams = _____

**(2)**

(b) Calcium carbonate in the indigestion tablet reacts with hydrochloric acid in the stomach.

Which gas is produced?

Tick (✓) **one** box.

Carbon dioxide ☐

Chlorine ☐

Hydrogen ☐

Oxygen ☐

**(1)**

(c) Sodium hydrogencarbonate has the chemical formula $NaHCO_3$

How many different elements are in sodium hydrogencarbonate?

Tick (✓) **one** box.

3 ☐

4 ☐

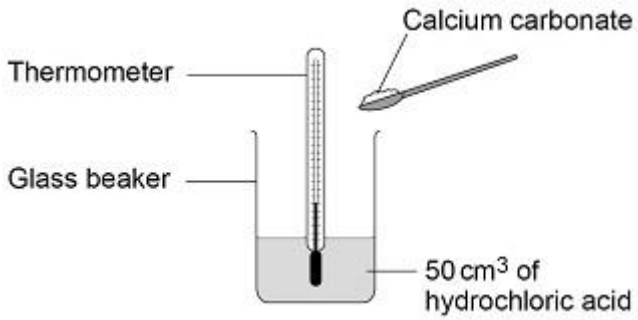
5 ☐

6 ☐

**(1)**

A student investigated the temperature change when different masses of calcium carbonate were reacted with 50 $cm^3$ of hydrochloric acid.

The diagram below shows the apparatus used.




This is the method used.

1. Add 50 $cm^3$ of hydrochloric acid to a glass beaker.

2. Record the temperature of the hydrochloric acid.

3. Add 1 g of calcium carbonate to the hydrochloric acid.

4. Stir the mixture.

5. Record the highest temperature of the mixture.

6. Repeat steps 1–5 with different masses of calcium carbonate.

(d) Which two changes would increase the accuracy of the results?

Tick (✓) **two** boxes.

- Add a lid to the top of the glass beaker ☐
- Add indicator to the hydrochloric acid ☐
- Use 100 $cm^3$ of hydrochloric acid ☐
- Use a polystyrene cup instead of the glass beaker ☐
- Use a thermometer with intervals of 5 °C instead of 1 °C ☐

**(2)**

(e) The student added different masses of calcium carbonate to the hydrochloric acid.

Which **two** terms describe the mass of calcium carbonate in this investigation?

Tick (✓) **two** boxes.

- Categoric variable ☐
- Continuous variable ☐
- Control variable ☐
- Dependent variable ☐
- Independent variable ☐

**(2)**

**(Total 8 marks)**

**Q6.**

The country Iceland is a major producer of aluminium.

Aluminium is extracted from aluminium oxide using electrolysis.

Electrolysis requires a large amount of electricity.

Iceland generates all of its electricity from renewable resources.

(a) Which of the following is a renewable resource?

Tick (✓) **one** box.

Coal ☐

Crude oil ☐

Hydroelectricity ☐

Nuclear fuel ☐

**(1)**

(b) Why is aluminium produced in Iceland?

Tick (✓) **one** box.

Conserves aluminium ore ☐

Plentiful supply of cheap electricity ☐

Uses up non-renewable resources ☐

**(1)**

(c) Aluminium is extracted from aluminium oxide.

Complete the balanced equation for the reaction.

$$2\ Al_2O_3 \rightarrow \_\_\_\_\_\ Al + \_\_\_\_\_\ O_2$$

**(2)**

(d) What type of reaction takes place when oxygen is removed from aluminium oxide?

Tick (✓) **one** box.

Combustion ☐

Neutralisation ☐

Reduction ☐

**(1)**

(e) During electrolysis, aluminium ions ($Al^{3+}$) move towards the negative electrode.

Explain why aluminium ions move towards the negative electrode.

_____

_____

_____

_____

**(2)**

(f) At the negative electrode, an aluminium ion ($Al^{3+}$) gains electrons to become an aluminium atom.

How many electrons does each aluminium ion gain?

Number of electrons = _____

**(1)**

(g) The positive electrode is made of carbon.

Oxygen is produced at the positive electrode.

The oxygen reacts with the carbon.

Complete the word equation for the reaction.

Carbon + oxygen → _____

**(1)**

(h) Why do the positive electrodes need to be replaced regularly?

_____

_____

_____

**(1)**

(i) A ceramic material can be used as the positive electrode in the electrolysis of aluminium oxide.

The ceramic material has the following properties:

- high melting point
- unreactive.

Explain why each property is important when the ceramic material is used in the electrolysis of aluminium oxide.

High melting point _____

_____

_____

_____

Unreactive _____

_____

_____

_____

**(4)**

**(Total 14 marks)**

## Q7.

This question is about acids and bases.

(a) Which ion is found in all acids?

Tick **one** box.

$Cl^-$ ☐ $H^+$ ☐ $Na^+$ ☐ $OH^-$ ☐

**(1)**

(b) Zinc nitrate can be produced by reacting an acid and a metal oxide.

Name the acid and the metal oxide used to produce zinc nitrate.

Acid _____

Metal oxide _____

**(2)**

(c) In an equation, zinc nitrate is written as $Zn(NO_3)_2(aq)$.

What does (aq) mean?

Tick **one** box.

Dissolved in water ☐

Insoluble ☐

Not all reacted ☐

Reactant ☐

**(1)**

(d) The pH of a solution is 8

Some hydrochloric acid is added to the solution.

Suggest the pH of the solution after mixing.

pH = _____

**(1)**

(e) **Table 1** shows the solubility of three solids in water at room temperature.

**Table 1**

| **Solid** | **The mass of the solid that dissolves in 100 $cm^3$ of water** |
|---|---|
| Phosphorus oxide | 50 g |
| Silicon dioxide | 0 g |
| Sodium hydroxide | 100 g |

A teacher labelled these three solids **A**, **B** and **C**.

She gave a student the information shown in **Table 2**

**Table 2**

| **Solid** | **Observation when added to water** | **pH of the solid in water** |
|---|---|---|
| **A** | colourless solution | 14 |
| **B** | colourless solution | 2 |
| **C** | solid does not dissolve | 7 |

Describe a method that could be used to identify each of the three solids **A**, **B** and **C**.

You must use an indicator in the method.

Use information in **Table 1** and **Table 2**

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

**(Total 9 marks)**

## Q8.

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.

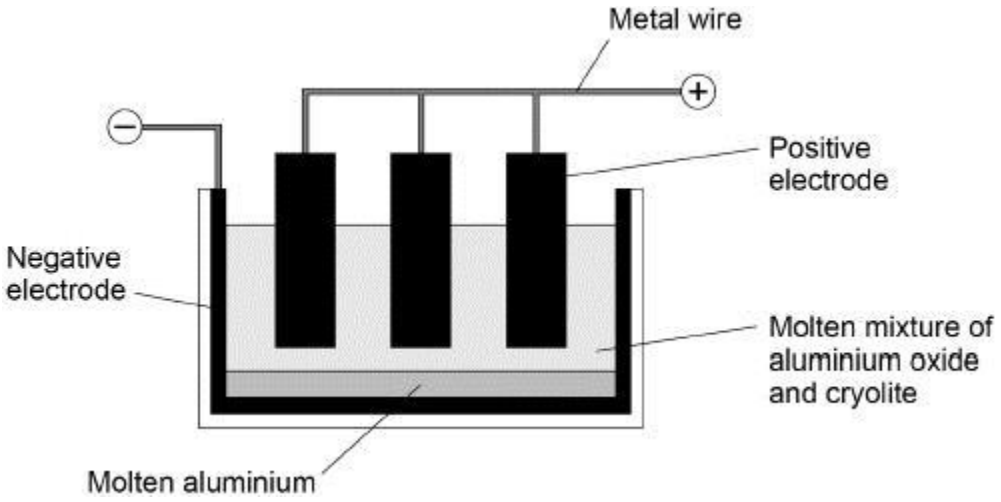
Number of electrons _____

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 _____

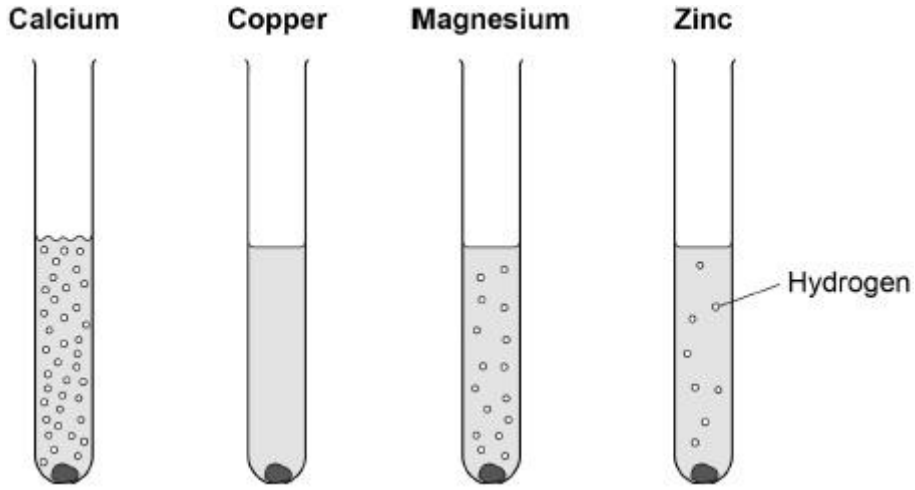
**(3)**

**(Total 9 marks)**

## Q9.

This question is about reactions of metals.

The diagram shows what happens when calcium, copper, magnesium and zinc are added to hydrochloric acid.




(a) What is the order of decreasing reactivity of these four metals?

Tick (✓) **one** box.

Zn Ca Cu Mg ☐

Ca Cu Mg Zn ☐

Ca Zn Ca Mg ☐

Ca Mg Zn Cu ☐

**(1)**

A student wants to make a fair comparison of the reactivity of the metals with hydrochloric acid.

(b) Name **two** variables that must be kept constant.

1 _____

_____

2 _____

_____

**(2)**

(c) What is the independent variable in this reaction?

_____

_____ **(1)**

(d) Predict the reactivity of beryllium compared with magnesium.

Give a reason for your answer.

Use the periodic table.

_____

Reason _____

_____

_____

**(2)**

(e) A solution of hydrochloric acid contains 3.2 g of hydrogen chloride in 50 $cm^3$

Calculate the concentration of hydrogen chloride in g per $dm^3$

_____

_____

_____

_____

Concentration = _____ g per $dm^3$

**(3)**

**(Total 9 marks)**

## Q10.

This question is about salts.

Ammonium nitrate solution is produced when ammonia gas reacts with nitric acid.

(a) Give the state symbol for ammonium nitrate solution.

_____

**(1)**

(b) What is the formula of nitric acid?

Tick (✓) **one** box.

HCl ☐

$HNO_3$ ☐

$H_2SO_4$ ☐

$NH_4OH$ ☐

**(1)**

(c) Ammonia gas dissolves in water to produce ammonia solution.

Ammonia solution contains hydroxide ions, $OH^-$

A student adds universal indicator to solutions of nitric acid and ammonia.

What colour is observed in each solution?

Colour in nitric acid _____

Colour in ammonia solution _____

**(2)**

(d) The student gradually added nitric acid to ammonia solution.

Which row, **A**, **B**, **C** or **D**, shows the change in pH as the nitric acid is added until in excess?

Tick (✓) **one** box.

| | **pH of ammonia solution at start** | **pH after addition of excess nitric acid** | |
|---|---|---|---|
| **A** | 10 | 7 | ☐ |
| **B** | 2 | 10 | ☐ |
| **C** | 7 | 1 | ☐ |
| **D** | 10 | 2 | ☐ |

**(1)**

(e) Calculate the percentage by mass of oxygen in ammonium nitrate ($NH_4NO_3$).

Relative atomic masses ($A_r$): H = 1 N = 14 O = 16

Relative formula mass ($M_r$): $NH_4NO_3$ = 80

Percentage by mass of oxygen = _____ %

**(3)**

(f) Describe a method to investigate how the temperature changes when different masses of ammonium nitrate are dissolved in water.

You do **not** need to write about safety precautions.

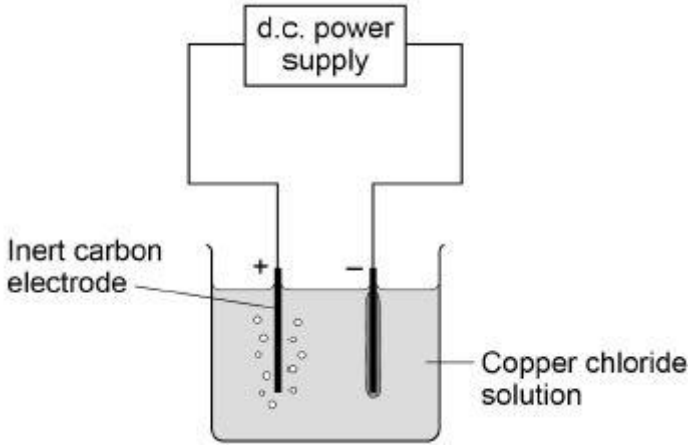
**(6)**
**(Total 14 marks)**

## Q11.

This question is about electrolysis.

A student investigates the mass of copper produced during electrolysis of copper chloride solution.

The diagram below shows the apparatus.




(a) Which gas is produced at the positive electrode (anode)?

Tick **one** box.

carbon dioxide ☐

chlorine ☐

hydrogen ☐

oxygen ☐

**(1)**

(b) Copper is produced at the negative electrode (cathode).

What does this tell you about the reactivity of copper?

Tick **one** box.

Copper is less reactive than hydrogen ☐

Copper is less reactive than oxygen ☐

Copper is more reactive than carbon ☐

Copper is more reactive than chlorine ☐

**(1)**

The table below shows the student's results.

| | **Total mass of copper produced in mg** | | | |
|---|---|---|---|---|
| **Time in mins** | **Experiment 1** | **Experiment 2** | **Experiment 3** | **Mean** |
| **1** | 0.60 | 0.58 | 0.62 | 0.60 |
| **2** | 1.17 | 1.22 | 1.21 | 1.20 |
| **4** | 2.40 | 2.41 | 2.39 | 2.40 |
| **5** | 3.02 | **X** | 3.01 | 3.06 |

(c) Determine the **mean** mass of copper produced after 3 minutes.

_____

_____

Mass = _____ mg

**(1)**

(d) Calculate the mass **X** of copper produced in **Experiment 2** after 5 minutes.

Use the table above.

_____

_____

_____

_____

Mass **X** = _____ mg

**(2)**

(e) The copper chloride solution used in the investigation contained 300 grams per $dm^3$ of solid $CuCl_2$ dissolved in 1 $dm^3$ of water.

The students used 50 $cm^3$ of copper chloride solution in each experiment.

Calculate the mass of solid copper chloride used in each experiment.

_____

_____

_____

_____

_____

_____

Mass = _____ g

**(3)**

**(Total 8 marks)**

## Q12.

A student plans a method to prepare pure crystals of copper sulfate.

The student's method is:

1. Add one spatula of calcium carbonate to dilute hydrochloric acid in a beaker.
2. When the fizzing stops, heat the solution with a Bunsen burner until all the liquid is gone.

The method contains several errors and does not produce copper sulfate crystals.

Explain the improvements the student should make to the method so that pure crystals of copper sulfate are produced.

**(Total 6 marks)**

**Q13.**

This question is about acids, alkalis and bases.

A student reacted zinc oxide powder with hydrochloric acid to produce zinc chloride solution.

(a) Complete the equation for the reaction by writing the state symbols.

$$ZnO(\_\_\_\_\_) + 2\ HCl(\_\_\_\_\_) \rightarrow ZnCl_2(\_\_\_\_\_) + H_2O(\_\_\_\_\_)$$

**(2)**

(b) Give **one** way that the student could speed up the reaction between zinc oxide powder and hydrochloric acid.

_____

_____

**(1)**

Hydrochloric acid was the limiting reactant.

(c) How could the student know when all the hydrochloric acid has reacted?

_____

_____

**(1)**

(d) How could the student obtain zinc chloride solution from the reaction mixture when all the hydrochloric acid has reacted?

_____

_____

**(1)**

(e) Describe how zinc chloride crystals are produced from zinc chloride solution.

_____

_____

_____

_____

**(2)**

Sulfuric acid and sodium hydroxide react to produce sodium sulfate.

(f) Sulfuric acid is gradually added to sodium hydroxide solution.

The pH of the mixture changes as the sulfuric acid is added until in excess.

Suggest the pH at:

- the start before sulfuric acid is added
- the end when sulfuric acid is in excess.

pH at start = _____

pH at end = _____

**(2)**

(g) Complete the symbol equation for the preparation of sodium sulfate.

You should balance the equation.

**(2)**

(h) A solution of hydrochloric acid had a hydrogen ion concentration of 1.0 mol/dm$^3$

Water was added to the hydrochloric acid until the pH increased by 1

What was the hydrogen ion concentration of the hydrochloric acid after water had been added?

Tick (✓) **one** box.

100 mol/dm$^3$ ☐

10 mol/dm$^3$ ☐

0.10 mol/dm$^3$ ☐

0.010 mol/dm$^3$ ☐

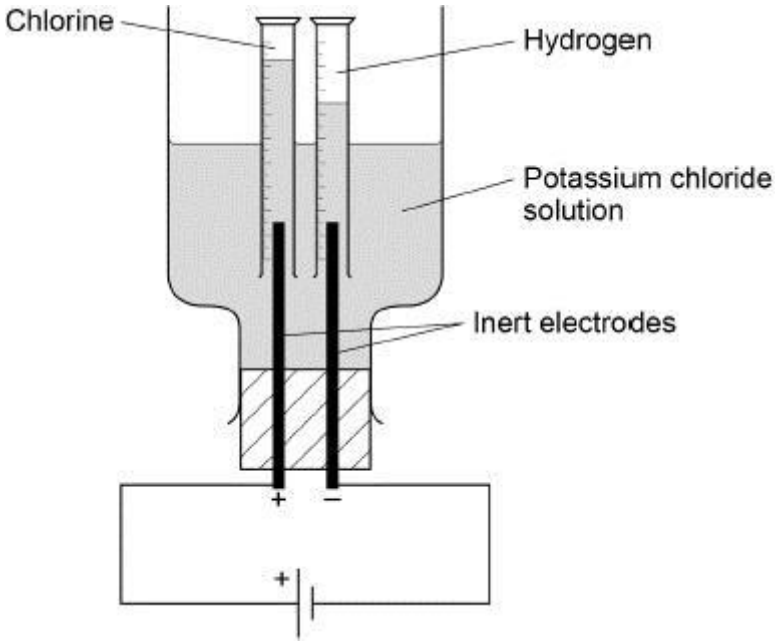
**(1)**

**(Total 12 marks)**

## Q14.

A student investigated the electrolysis of potassium chloride solution.

The diagram below shows the apparatus used.




(a) Why are inert electrodes used?

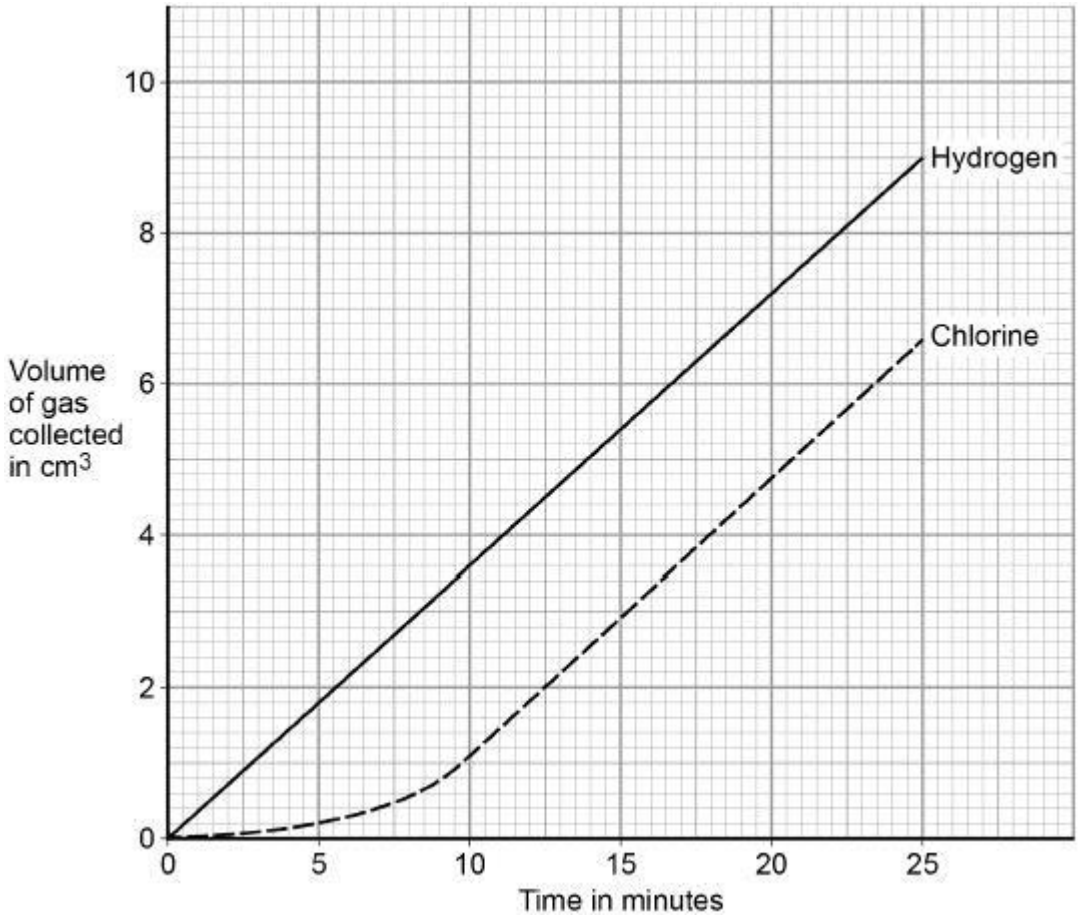
_____

_____

**(1)**

The student measured the volume of gas collected at each electrode for 25 minutes.

The graph below shows the results.




(b) Compare the **rate** of collection of hydrogen and of chlorine.

Give **one** similarity and **one** difference in the **rate** of collection of the gases.

Similarity _____

_____

Difference _____

_____

**(2)**

(c) The rate of production of hydrogen and of chlorine at the electrodes is the same.

Explain how the graph on the graph above shows that chlorine is more soluble than hydrogen.

_____

_____

_____

_____

**(2)**

(d) Explain why hydrogen gas is produced at the negative electrode in the electrolysis of potassium chloride solution.

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(e) Write the half equation for the production of chlorine gas at the positive electrode.

_____ → _____ + _____

**(2)**

**(Total 11 marks)**

## Q15.

A student investigated the temperature change when magnesium was added to copper sulfate solution.

This is the method used.

1. Pour 30 $cm^3$ of copper sulfate solution into a polystyrene cup.
2. Measure the temperature of copper sulfate solution every minute for 3 minutes.
3. Add magnesium on the fourth minute.
4. Measure the temperature of the mixture at 5 minutes and then every minute up to 14 minutes.

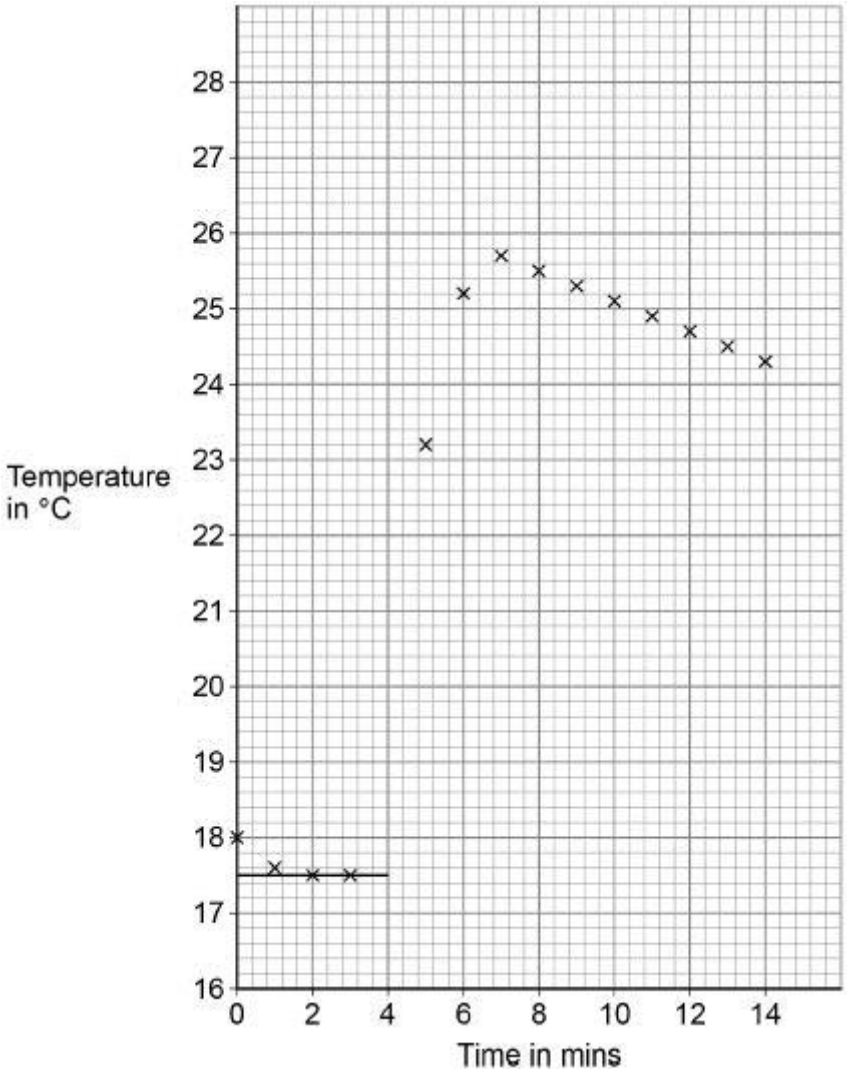
(a) What is the dependent variable in this investigation?

_____

**(1)**

The student used the results to plot a graph.

The image below shows the graph.



(b) Suggest why the copper sulfate solution was left for four minutes before adding the magnesium.

_____

_____

**(1)**

(c) Complete the graph above by:
- drawing a line of best fit through all the points after 7 minutes
- extending the line back to 4 minutes.

**(2)**

(d) The temperature change for the reaction is the temperature difference between the two graph lines at 4 minutes.

Determine the temperature change for the reaction.

Use the graph above.

_____

_____

Temperature change = _____ °C

**(2)**

(e) Explain why the temperature of the mixture decreases after 7 minutes.

_____

_____

_____

_____

**(2)**

(f) The student repeated the experiment with an unknown metal **Q** instead of magnesium.

All the other variables were kept the same.

The student recorded a smaller temperature change.

Suggest the identity of metal **Q**.

Give **one** reason for your answer.

Metal **Q** _____

Reason _____

_____

**(2)**

(g) A copper sulfate solution contained 0.100 moles of copper sulfate dissolved in 0.500 $dm^3$ of water.

Calculate the mass of copper sulfate in 30.0 $cm^3$ of this solution.

Relative formula mass ($M_r$): $CuSO_4$ = 159.5

Mass = _____ g

**(4)**

**(Total 14 marks)**

## Q16.

This question is about electrolysis.

(a) Some metals are extracted from molten compounds using electrolysis.

Why is electrolysis used to extract some metals?

_____

_____

**(1)**

(b) Aluminium is produced by electrolysis of a molten mixture.

What **two** substances does the molten mixture contain?

1 _____

2 _____

**(2)**

(c) Copper and chlorine are produced when molten copper chloride is electrolysed.

Complete the half equation for the reaction at each electrode.

Half equation at negative electrode

$Cu^{2+}$ _____ → _____

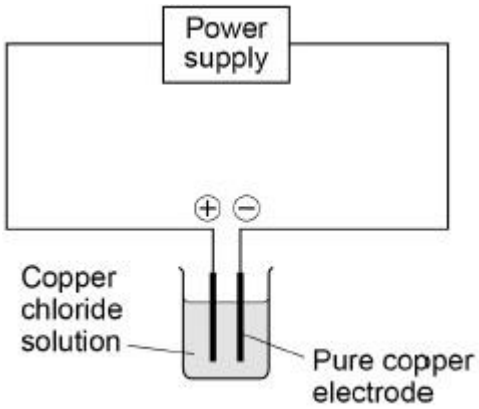
Half equation at positive electrode

$2\ Cl^{-}$ → _____

**(2)**

The **Figure 1** shows the apparatus a student used to electrolyse copper chloride solution.

**Figure 1**




The student:

- measured the mass of copper deposited on the negative electrode after 60 minutes
- compared the mass deposited with the expected value.

(d) Suggest **two** reasons why the mass deposited was different from the expected value.

1 _____

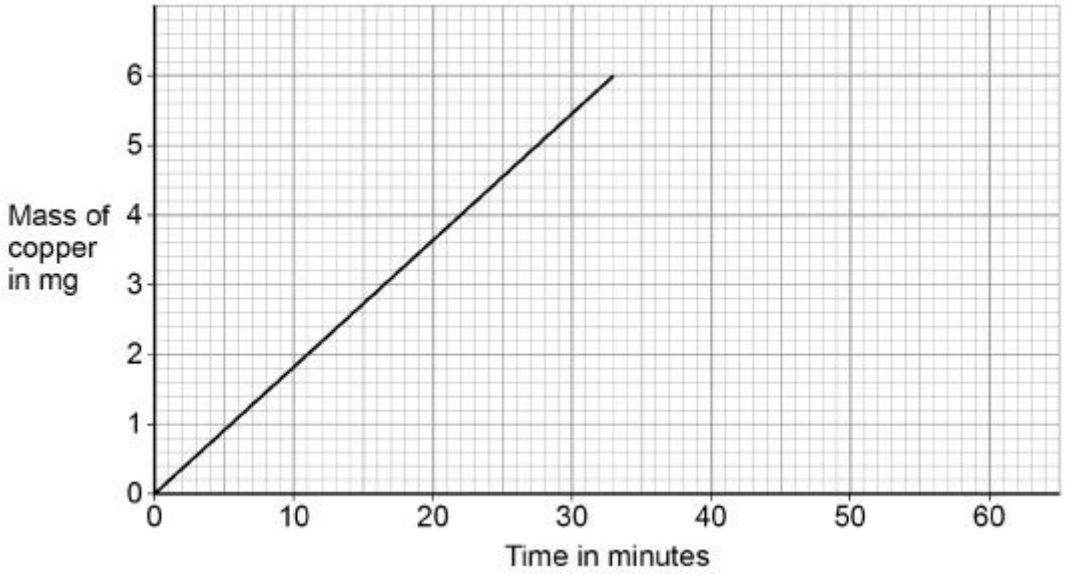
_____

2 _____

_____

**(2)**

(e) **Figure 2** shows the expected mass of copper produced each minute.




Determine the expected mass of copper after 24 hours.

Use **Figure 2**.

_____

_____

_____

_____

_____

_____

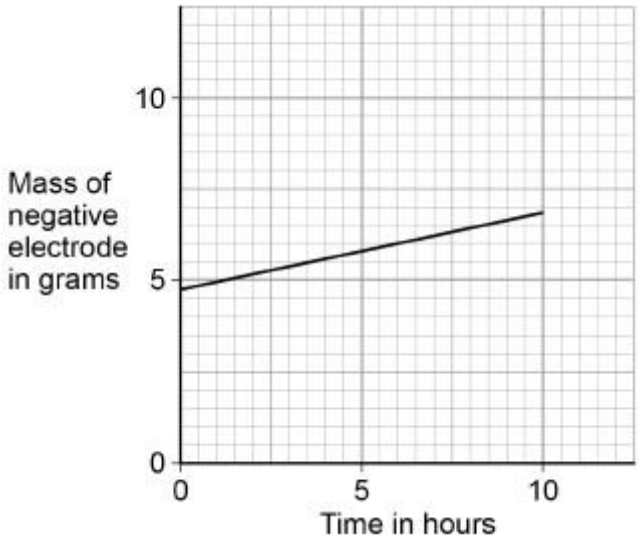
Mass = _____ mg

**(3)**

Silver nitrate solution is electrolysed.

**Figure 3** shows the change in mass of the negative electrode over 10 hours.

**Figure 3**




(f) Determine the mass of the negative electrode at the start of the experiment.

Use **Figure 3.**

_____

**(1)**

(g) Calculate the gradient of the line in **Figure 3**.

Give the unit.

_____

_____

_____

_____

_____

_____

Gradient _____

Unit _____

**(3)**

**(Total 14 marks)**

## Q17.

This question is about iron.

Iron reacts with dilute hydrochloric acid to produce iron chloride solution and one other product.

(a) Name the other product.

_____

**(1)**

(b) Suggest how any unreacted iron can be separated from the mixture.

_____

_____

**(1)**

Magnesium reacts with iron chloride solution.

$$3\ Mg + 2\ FeCl_3 \longrightarrow 2\ Fe + 3\ MgCl_2$$

(c) 0.120 g of magnesium reacts with excess iron chloride solution.

Relative atomic masses ($A_r$): Mg = 24 Fe = 56

Calculate the mass of iron produced, in mg

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Mass of iron = _____ mg

**(5)**

(d) Explain which species is reduced in the reaction between magnesium and iron chloride.

$$3\ Mg + 2\ FeCl_3 \longrightarrow 2\ Fe + 3\ MgCl_2$$

Your answer should include the half equation for the reduction.

**(3)**

**(Total 10 marks)**

## Q18.

A scientist does two tests on four white solids. The solids are labelled **A**, **B**, **C** and **D**.

**Test 1** Adds the sample of the solid to distilled water and stirs.

**Test 2** Measures the pH of the solution after **Test 1**

**Table 1** shows the results.

**Table 1**

| Solid | Appearance after stirring | pH |
|---|---|---|
| **A** | colourless solution, no solid | 14 |
| **B** | colourless solution, no solid | 3 |
| **C** | colourless solution, solid remains | 9 |
| **D** | colourless liquid, solid remains | 7 |

These four solids are:

- magnesium oxide
- phosphorus oxide
- silicon dioxide
- sodium oxide.

**Table 2** shows the solubility of these four solids in water.

**Table 2**

| Solid | Solubility in grams per 100 $cm^3$ of water |
|---|---|
| Magnesium oxide | 0.01 |
| Phosphorus oxide | 52 |
| Silicon dioxide | 0 |
| Sodium oxide | 109 |

(a) Identify the solids **A**, **B**, **C** and **D**.

Explain your answers.

**(6)**

(b) 10 $cm^3$ of solution **B** is added to a beaker.

Distilled water is added to the beaker until the final volume in the beaker is 1000 $cm^3$

The pH of the solution is measured before and after distilled water is added.

**Table 3** shows the results.

**Table 3**

| **Volume of solution in beaker** | **pH of solution B** |
|---|---|
| 10 $cm^3$ | 3 |
| 1000 $cm^3$ | **X** |

Calculate the value of **X**.

_____

_____

_____

_____

**X** = _____

**(2)**

**(Total 8 marks)**

## Q1.

(a) 1

**1**

(b) hydrochloric acid

**1**

(c) salt

**1**

(d) sodium hydroxide

**1**

(e) CuO

**1**

(f) any **one** from:

- increase the concentration of the acid
- increase the surface area of the copper oxide

  *allow use powdered copper oxide*
- warm / heat the mixture

  *ignore increase room temperature*

  *allow add catalyst*

  *ignore stir*

**1**

(g) in excess

**1**

(h)

**1**

(i) crystallisation

*allow evaporation*

**1**

**[9]**

## Q2.

(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]**

## Q3.

(a) hydrochloric acid

**1**

(b) (black) solid remains (after stirring)

*allow copper oxide remains*

*allow no more copper oxide reacts*

**1**

(c)

first stage **B**

second stage **A**

third stage **C**

fourth stage **D**

*all 4 correct for **2** marks*

*allow **1** mark if either first stage or fourth stage is correct*

**2**

(d) (negative electrode) copper

*allow Cu*

**1**

*allow $Cl_2$ / Cl*

*do **not** accept chloride or $Cl^-$*

**1**

*if no other mark awarded allow **1** mark if elements are reversed*

(e) a reading of an increase in mass

correct linked reading of the increase in time

*e.g. 4 (mg) in 10 (mins) scores 2 marks*

**1**

**1**

correct evaluation of gradient

*e.g. ( $\frac{4}{10}$ =) 0.4 (mg per min)*

*allow correct calculation of gradient from incorrectly determined values for mass and/or time*

**1**

(f) cryolite

*this order only*

**1**

oxide

**1**

**[11]**

## Q4.

(a)

| | | |
|---|---|---|
| copper | Cu | 1 |
| sulfur | S | 1 |
| oxygen | O | 4 |

*If no rows correct, allow **1** mark for a correct column*

**3**

(b) copper oxide + sulfuric acid → copper sulfate (+ water)

*allow correct formulae*

**1**

(c) a base

**1**

(d) blue crystals and black powder

**1**

(e) (filter) funnel **and** (filter) paper labelled

**1**

(conical) flask / beaker labelled

*allow any suitable container labelled*

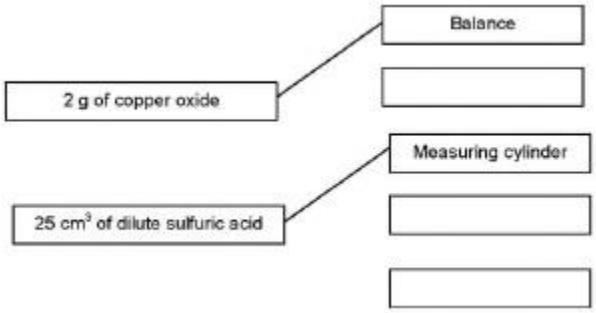
**1**

copper oxide (residue) labelled

*allow excess*

**1**

(f)




*extra line from measurement box negates the mark*

**2**

(g)

*an answer of 40 (g/dm$^3$) scores **2** marks*

*an answer of 0.04 (g/dm$^3$) scores **1** mark*

$1 \times \frac{1\,000}{25}$

**1**

= 40 (g/dm$^3$)

*allow correct calculation from an incorrect attempt at a unit conversion*

**1**

**[13]**

## Q5.

(a)

*an answer of 0.8 (g) scores **2** marks*

(mass in mg =) 800

**1**

(mass in g =) 0.8

*allow correct unit conversion using incorrectly calculated mass in milligrams*

**1**

(b) carbon dioxide

**1**

(c) 4

**1**

(d) add a lid to the top of the glass beaker

**1**

use a polystyrene cup instead of the glass beaker

**1**

(e) continuous variable

**1**

independent variable

**1**

**[8]**

**Q6.**

(a) hydroelectricity

**1**

(b) plentiful supply of cheap electricity

**1**

(c)

*an answer of*
*$2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$ scores **2** marks*

4(Al)

**1**

3($O_2$)

**1**

(d) reduction

**1**

(e) ($Al^{3+}$ ions are) positive

*do **not** accept aluminium atoms are positive, but 2nd marking point can still be scored*

**1**

(so) are attracted (to the negative electrode)

*allow (so) opposite charges attract*

**1**

(f) 3 / three

**1**

(g) carbon dioxide

*allow $CO_2$*
*allow carbon monoxide **or** CO*
*ignore carbon oxide*

**1**

(h) electrode / carbon / graphite reacts to produce a gas

*allow electrode / carbon / graphite is used up*
*ignore wears away*
*ignore corrodes / rusts*

**1**

(i) (high melting point)

(so) will not melt

**1**

in the high temperatures (in the electrolytic cell)

*ignore the electrolytic cell is very hot*

**1**

(unreactive)

(so) will not react

**1**

with oxygen

*allow (so) electrode doesn't need replacing*

**or**

with aluminium oxide

*ignore with aluminium*

**1**

**[14]**

## Q7.

(a) $H^+$

**1**

(b) nitric (acid) **or** $HNO_3$

**1**

zinc (oxide) or ZnO

**1**

*this order only*

(c) dissolved in water

**1**

(d) any value from 0 to less than 8

**1**

(e) **Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and logically sequenced.

**3–4**

**Level 1:** The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

**1–2**

**No relevant content**

**0**

**Indicative content**

- add universal indicator **or** wide range indicator

indicator turns blue / purple / violet (because pH = 14)
**or** has highest pH or is an alkali
so A is sodium hydroxide

indicator turns red (because pH = 2)
**or** has lowest pH **or** is an acid
so B is phosphorus oxide

indicator turns green (because pH = 7)
**or** neutral
so C is silicon dioxide

- add solid to water

A and B dissolve; C does not
so C is silicon dioxide

**[9]**

## Q8.

(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]**

**Q9.**

(a) Ca Mg Zn Cu

**1**

(b) any **two** from:

- mass (of metal / element)
  *allow weight*
- surface area (of metal / element)
  *ignore size*
  *ignore length*
- concentration (of acid)
  *ignore pH*
  *ignore strength*
- volume (of acid)
- temperature (of acid)
  *ignore room temperature*

**2**

(c) (type of) metal / element

**1**

(d) (beryllium is) less reactive

**1**

any **one** from:

- greater attraction between nucleus and outer electrons
- more energy is needed to remove electrons
- loss of electrons is more difficult
- outer electrons closer to nucleus
- less shielding

**1**

*allow converse answers for magnesium*
*MP2 only if MP1 is correct*
*allow higher in group*
*allow reactivity increases down the group*
*ignore reactivity series*

(e) $\frac{50}{1000}$ ($dm^3$)

**1**

= 0.05 ($dm^3$)

**1**

$(\frac{3.2}{0.05})$ 64 (g per $dm^3$)

**1**

**alternative approach:**

$\frac{3.2}{50}$ (1)

= 0.064 (1)

(× 1000) = 64 (g per $dm^3$) (1)

**alternative approach:**

$\frac{1000}{50}$ (1)

= 20 (1)

(× 3.2) = 64 (g per $dm^3$) (1)

*an answer of 64 (g per $dm^3$) scores **3** marks*

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

*an answer of 0.16 / 0.064 / 0.64 / 6.4 / 6.4 × $10^{-5}$ (g per dm3) gains **2** marks*

**[9]**

## Q10.

(a) (aq)

*allow aq*
*ignore aqueous*
*ignore formulae*

**1**

(b) $HNO_3$

**1**

(c) red

*allow orange or yellow*
*do **not** accept green*

**1**

purple
**or**
blue

*allow shades of purple e.g. violet*

**1**

(d) D

(e) 3 × 16 **or** 48

**1**

$\frac{48}{80}$ (×100)

**1**

60 (%)

**1**

*an answer of 60 (%) scores **3** marks*
*an answer of 20 (%) scores **2** marks for:*
$\frac{16}{80}$ *(× 100) (1)*
*= 20 (%) (1)*

(f) **Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

**5–6**

**Level 2:** The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

**3–4**

**Level 1:** The design/plan 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**

**Steps**

- use a suitable container e.g. test tube

- use insulation
- add water
- measure the initial water temperature (with a thermometer)
- add stated mass e.g. 1g **or** 1 spatula
- stir (to dissolve the solid)
- measure the final (allow lowest or highest) temperature of the solution
- calculate the temperature difference **or** determine graphically
- repeat with different masses
- repeat with the same volume of water

to access level 3 there must be an indication of how the temperature change is determined using different masses dissolved in the same quantity of water

**[14]**

## Q11.

(a) chlorine

**1**

(b) copper is less reactive than hydrogen

**1**

(c) 1.8 (mg)

*allow an answer in range 1.7−1.9*

**1**

(d) $\frac{3.02 + 3.01 + x}{3} = 3.06$

*allow any other suitable method*

**1**

3.15 (mg)

*if no other mark awarded allow 9.18 for **1** mark*

**1**

*an answer of 3.15 (mg) scores **2** marks*

(e) $\frac{50}{1000}$ **or** $\frac{1}{20}$ **or** 0.05

**1**

(0.05) × 300

*the second mark is dependent on the first mark being scored*

**1**

15 (g)

**1**

**or**

$\frac{300}{1000}$ **or** $\frac{3}{10}$ **or** 0.03 (1)

(0.3) × 50 (1)

*the second mark is dependent on the first mark being scored*

15 (g) (1)

*if no other mark awarded allow 150 **or** 15 000 for **1** mark*

**[8]**

## Q12.

**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

**5–6**

**Level 2:** Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

**3–4**

**Level 1:** Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

**1–2**

**No relevant content**

**0**

**Indicative content**

- uses sulfuric acid not hydrochloric acid
  **or** sulfuric acid needed
- uses copper carbonate / oxide not calcium carbonate
  **or** copper carbonate / oxide needed
- add solid until solid remains **or** is in excess **or** no more reacts / dissolves
  so that most / all of the acid reacts
- filter
  to remove excess **or** unreacted carbonate / oxide / solid
- heat gently **or** partially evaporate **or** leave
  until crystals appear **or** to crystallise

for **level 3** the correct chemicals must have been selected

**[6]**

## Q13.

(a) $ZnO$ (**s**) + HCl (**aq**) → $ZnCl_2$ (**aq**) + $H_2O$ (**l**)

*allow **1** mark for 2/3 correct state symbols*

**2**

(b) any **one** from:

- warm / heat the mixture
- increase the concentration of the (hydrochloric) acid

*ignore add a catalyst*

*ignore stir*

*ignore powder*

*ignore add more zinc oxide*

*do **not** accept volume / amount of (hydrochloric) acid*

*do **not** accept increase the surface area*

**1**

(c) zinc oxide remains

**or**

solid remains

*ignore colour*

*allow zinc oxide is added until in excess*

**1**

(d) filtration / filter

**1**

(e) heat

*do **not** accept heat to dryness*

**1**

leave to crystallise / cool

*allow leave to evaporate some water*

**1**

(f) (at start) value in range 12–14

*must be in this order*

**1**

(at end) value in range 0–3

**1**

(g) $2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2\ H_2O$

*allow 1 mark for $Na_2SO_4$ **and** $H_2O$*

**2**

(h) 0.10 $mol/dm^3$

**1**

**[12]**

## Q14.

(a) so the electrodes do not react (with electrolyte / gas / chlorine / hydrogen)

**1**

(b) similarity

any **one** from:

- both collected at a constant rate from 10 to 25 minutes
- hydrogen is collected at the same rate as chlorine from 10 minutes.

**1**

**difference**

any **one** from:

- rate of collection for hydrogen is greater than chlorine for the first 10 minutes
- overall rate of collection of hydrogen is greater than chlorine
- rate of collection of hydrogen is constant from 0 to 10 minutes but chlorine varies.

**1**

(c) less chlorine is collected

**1**

(because) most chlorine produced at the start of the reaction dissolves in the water

**1**

(d) water molecules break down to produce hydrogen ions (and hydroxide ions)

**1**

hydrogen ions are discharged as potassium is more reactive than hydrogen

**1**

(so) hydrogen ions gain electrons

*allow (so) hydrogen ions are reduced*

**1**

to form a hydrogen molecule

*ignore to form a hydrogen atom*

**1**

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

*allow **1** mark for $Cl^-$ (on the left) **and** $Cl_2$ (on the right)*

**2**

**[11]**

**Q15.**

(a) temperature (change)

**1**

(b) to reach a constant temperature

*allow to reach room temperature*

**1**

(c) line of best fit after 7 minutes

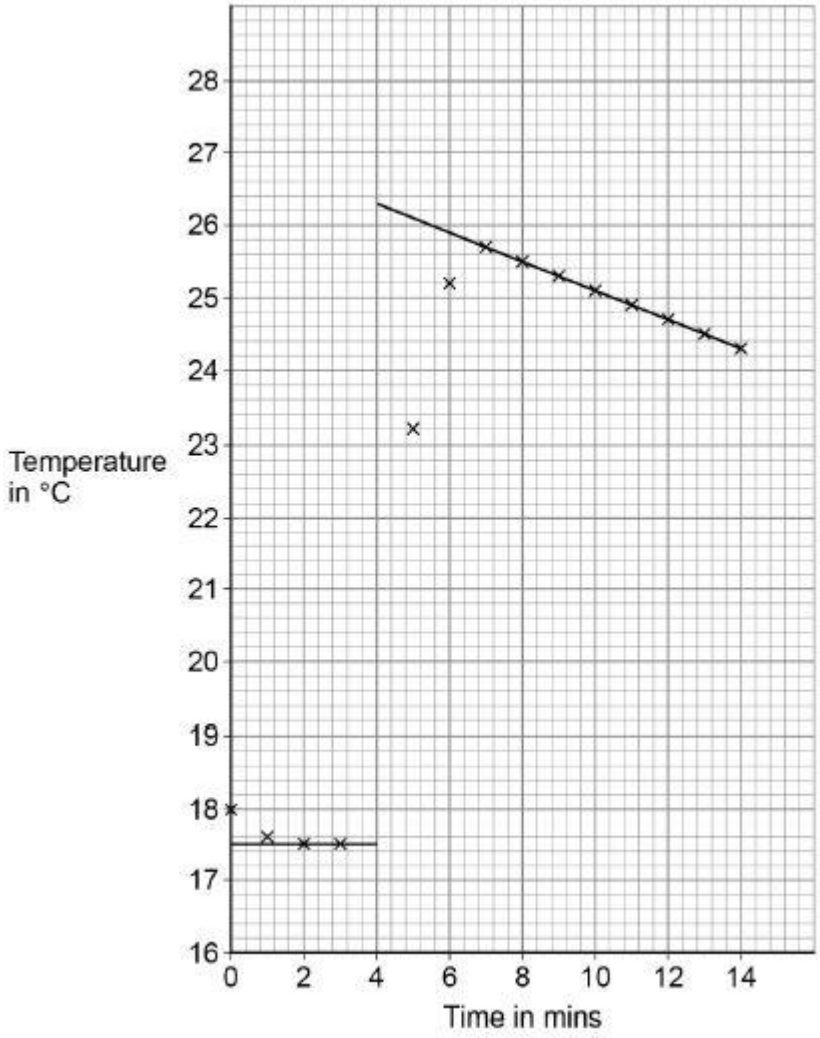
**1**

extends line back to 4 minutes

*ignore extension of line beyond 4 minutes*

**1**

the diagram below scores **2** marks




(d) (maximum **and** minimum values at 4 minutes)
26.3 (°C) **and** 17.5 (°C)

*allow ecf from **(c)***

**1**

(temperature change at 4 minutes)
= 8.8 (°C)

**1**

(e) the reaction finished / stopped

*allow maximum temperature has been reached*

**1**

(so) energy is lost to surroundings / atmosphere
**or**
(so the) solution cools (back to room temperature)

*allow heat for energy*

**1**

(f) aluminium / zinc / iron / beryllium

*allow Al / Zn / Fe / Be*

*do **not** accept copper, silver*

*MP2 dependent on a correct answer to MP1*

**1**

metal **Q** is less reactive (than magnesium)
**or**
metal **Q** is lower in reactivity series

*allow converse*

**1**

(g) (unit conversion)
30.0 $cm^3$ = 0.030 $dm^3$
**or**
0.500 $dm^3$ = 500 $cm^3$

**1**

(moles = $\frac{30}{500}$ × 0.1 =) 0.006

*allow correct use of incorrect / no unit conversion*

**or**

(moles = $\frac{0.030}{0.50}$ × 0.1 =) 0.006

**1**

mass = 0.006 × 159.5

*allow correct use of incorrect value for number of moles*

**1**

= 0.957 (g)

*allow 0.96 (g)*

**1**

**[14]**

## Q16.

(a) metal is too reactive to be extracted using carbon

**or**
metal reacts with carbon

*allow metal is more reactive than carbon*

**1**

(b) aluminium oxide

*ignore bauxite **or** aluminium ore*

**1**

cryolite

**1**

*either order*

(c)

*allow multiples*

negative electrode:
$Cu^{2+} + 2e^- \longrightarrow Cu$

**1**

positive electrode:
$2\ Cl^- \longrightarrow Cl_2 + 2e^-$

*allow $2\ Cl^- - 2e^- \longrightarrow Cl_2$*

**1**

(d) any **two** from:

- concentration / volume of solution was different
- impurities in solution
- error in timing
- copper falls off (electrode)

  *allow copper at bottom of beaker*
- copper removed when drying electrode
- electrode not dry (when weighed)
- voltage / current was different

  *ignore power supply ignore recorded mass inaccurately*

**2**

(e)

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

reading of mass at stated time

*allow tolerance of* $\pm \frac{1}{2}$ *small square*
*eg at 30 minutes value is 5.4 (mg)*

**1**

factor from time to 24 hours

*eg* $5.4 \times 48$ $\left(= \frac{24 \text{ hours}}{30 \text{ minutes}}\right)$

*allow correct calculation using incorrectly read value for mass at time quoted*

**1**

correct evaluation

*eg = 259 (mg)*

**1**

**alternative approach:**

calculates the gradient (1)

*eg (1.8 ÷ 10) = 0.18*

gradient × time in minutes in 24 hours (1)

*eg 0.18 × 24 × 60*

***or***

*eg 0.18 × 1440*

*allow correct use of incorrectly determined gradient*

correct evaluation (1)

*eg = 259 (mg)*

(f) 4.75 (g)

*allow values in range 4.7 − 4.8 (g)*

**1**

(g)

*an answer in the range 0.18–0.25 scores **2** marks*
*(**3** marks with correct unit)*

(working)
Y increase **and** X increase measured from graph

*allow ecf from part **(f)***

**and** substitution into $\frac{\text{Y increase}}{\text{X increase}}$

*eg* $= \frac{2.0}{10}$

**1**

correct evaluation

*eg = 0.2*

**1**

(units) g/hour

*allow g/h or g/hr **or** g per hour*

**1**

**[14]**

## Q17.

(a) hydrogen **or** $H_2$

*allow hydrogen gas*
*ignore H without the 2 subscript*

**1**

(b) filtration / filter

*allow magnet **or** decant*
*ignore heating*

**1**

(c) $(Mg)\ \frac{0.12}{24}$ or 0.005 (moles)

*mark is for ÷ by 24*

**1**

$(Fe)\ \frac{2}{3} \times 0.005 = 0.00333 \times 56$

*mark is for* $\times \frac{2}{3}$

**1**

(mass Fe) = 0.00333 × 56

*mark is for × 56*

**1**

= 0.1866 (g)

**1**

= 187 (mg)

**1**

*an answer of 280 (mg) scores **4** marks*
*an answer of 0.280 scores **3** marks (no ratio from equation)*
*184 scores **0** [= (3 × 24) + (2 × 56)]*

**OR**

$(Mg) = \frac{0.12}{(3 \times 24 =)72}\ (1)$

$= 0.00166$ **or** $\frac{1}{600}$ (moles) (1)

(mass of Fe) = 0.00166

**or** $\frac{1}{600} \times 112 (2 \times 56)$ (1)

= 0.1866 (g) (1)

187 (mg) (1)

**OR**

72 g Mg ⟶ 112g Fe (1)

$1\ g\ Mg \rightarrow \frac{112}{72}$ **or** 1.56 g Fe (1)

$0.12\ g\ Mg \rightarrow \frac{112}{72} \times 0.12$ (1)

= 0.1866 (g) (1)

= 187 (mg) (1)

*an answer of 185−190 (mg) scores **5** marks*

*an answer of 0.185−0.19 scores **4** marks*

(d) $Fe^{3+}$

**1**

(because) reduction is gain <u>of electrons</u>

*allow change in oxidation state / (+)3 to 0*

**1**

$Fe^{3+} + 3e^{(-)} \longrightarrow Fe$

**1**

**[10]**

## Q18.

(a) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

**5–6**

**Level 2:** Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

**3–4**

**Level 1:** Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

**1–2**

**Indicative content**

A is sodium oxide
B is phosphorus oxide
C is magnesium oxide
D is silicon dioxide

**linked statements:**

A is sodium oxide
because it has highest pH **or** pH = 14 **or** is a strong alkali

B is phosphorus oxide
because it has lowest pH **or** pH = 3 **or** is an acid

C is magnesium oxide
because it has 2nd highest pH **or** pH = 9 **or** is a (weak) alkali

D is silicon dioxide
because it is neutral **or** pH = 7

**or**

A and B are sodium oxide **or** phosphorus oxide
because both soluble **or** no solid remains

C is magnesium oxide
because it will be the colourless solution with solid remaining

D is silicon dioxide
because it will be the colourless liquid with solid remaining

for **level 3** the solids must be correctly identified

(b) dilution by a factor of 100

*allow pH changes by 1 when solution is diluted by factor of 10*
***or***
*allow pH changes by 2*

**1**

(pH =) 5

**1**

*an answer of (pH=) 5 gains **2** marks*

**[8]**