

This question is about iron.

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

1.1

Name the other product.

[1 mark]

This question is about iron.

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

1.2

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

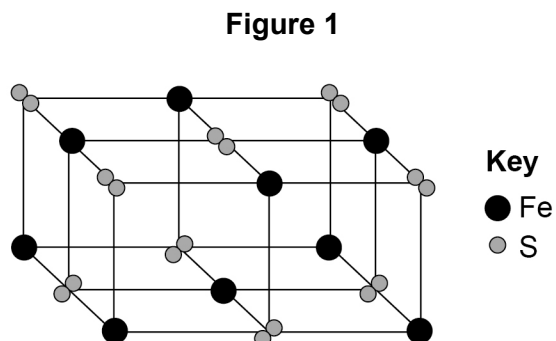
[1 mark]

This question is about metals and metal compounds.

2.1

Iron pyrites is an ionic compound.

Figure 1 shows a structure for iron pyrites.



Determine the formula of iron pyrites.

Use **Figure 1**.

[1 mark]

2.2

An atom of iron is represented as ${}^{56}_{26}\text{Fe}$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

Nickel is extracted from nickel oxide by reduction with carbon.

2.3

Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

Table 2 shows the student's results.

Table 2

Metal	Temperature increase in °C
Copper	0
Iron	13
Magnesium	43
Zinc	17

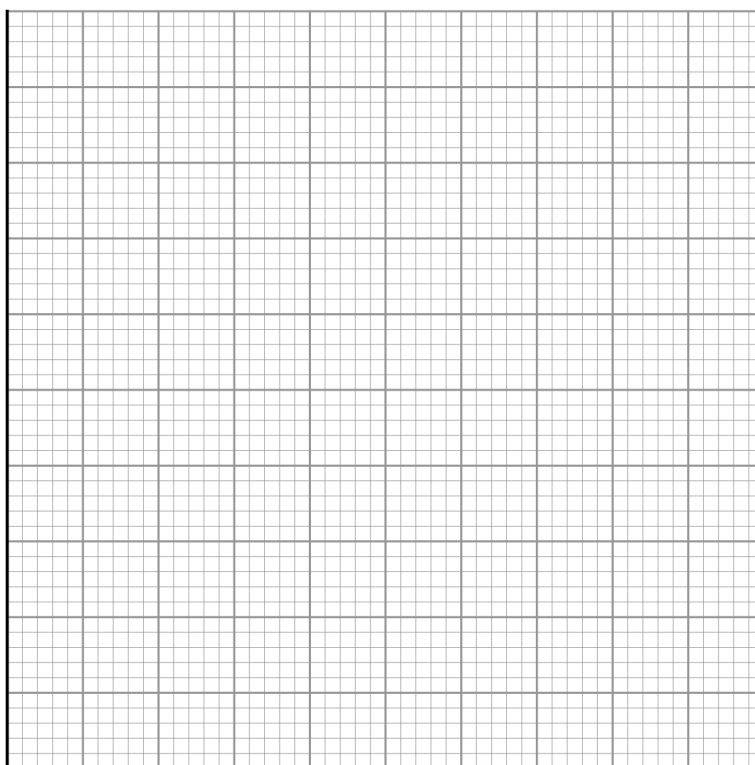
3.1

Plot the data from **Table 2** on **Figure 4** as a bar chart.

[2 marks]

Figure 4

Temperature
increase
in °C



• • • •

A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

Table 2 shows the student's results.

Table 2

Metal	Temperature increase in °C
Copper	0
Iron	13
Magnesium	43
Zinc	17

3.2

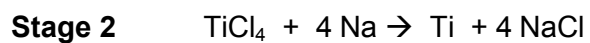
The temperature change depends on the reactivity of the metal.

The student's results are used to place copper, iron, magnesium and zinc in order of their reactivity.

Describe a method to find the position of an unknown metal in this reactivity series.

Your method should give valid results.

[4 marks]

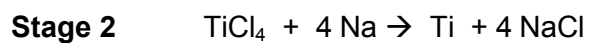


4.1

Water must be kept away from the reaction in **Stage 2**.

Give **one** reason why it would be hazardous if water came into contact with sodium.

[1 mark]



In **Stage 2**, sodium displaces titanium from titanium chloride.

4.2

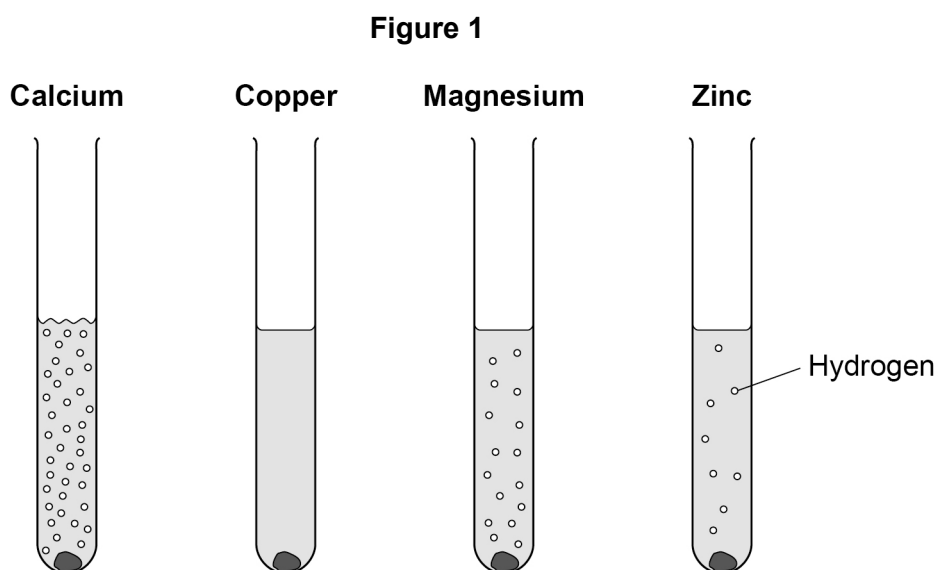
Sodium atoms are oxidised to sodium ions in this reaction.

Why is this an oxidation reaction?

[1 mark]

This question is about reactions of metals.

Figure 1 shows what happens when calcium, copper, magnesium and zinc are added to hydrochloric acid.



5.1

What is the order of decreasing reactivity of these four metals?

[1 mark]

Tick (✓) **one** box.

Zn Ca Cu Mg

☐

Ca Cu Mg Zn

☐

Cu Zn Ca Mg

☐

Ca Mg Zn Cu

☐

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

5.2

Name **two** variables that must be kept constant.

[2 marks]

1 _____

2 _____

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

5.3

What is the independent variable in this reaction?

[1 mark]

6.1 Some metals are extracted from molten compounds using electrolysis.

Why is electrolysis used to extract some metals?

[1 mark]

7.1

What happens in the reaction between magnesium and hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

Electron sharing

☐

Electron transfer

☐

Proton transfer

☐

8.1 An aluminium atom is represented as:



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

[2 marks]

Number of electrons _____

Number of neutrons _____

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

What is meant by the term reduction?

[1 mark]

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

This is the method used.

1. Pour 30 cm³ 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.

9.1

What is the dependent variable in this investigation?

[1 mark]

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

This is the method used.

1. Pour 30 cm³ 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.

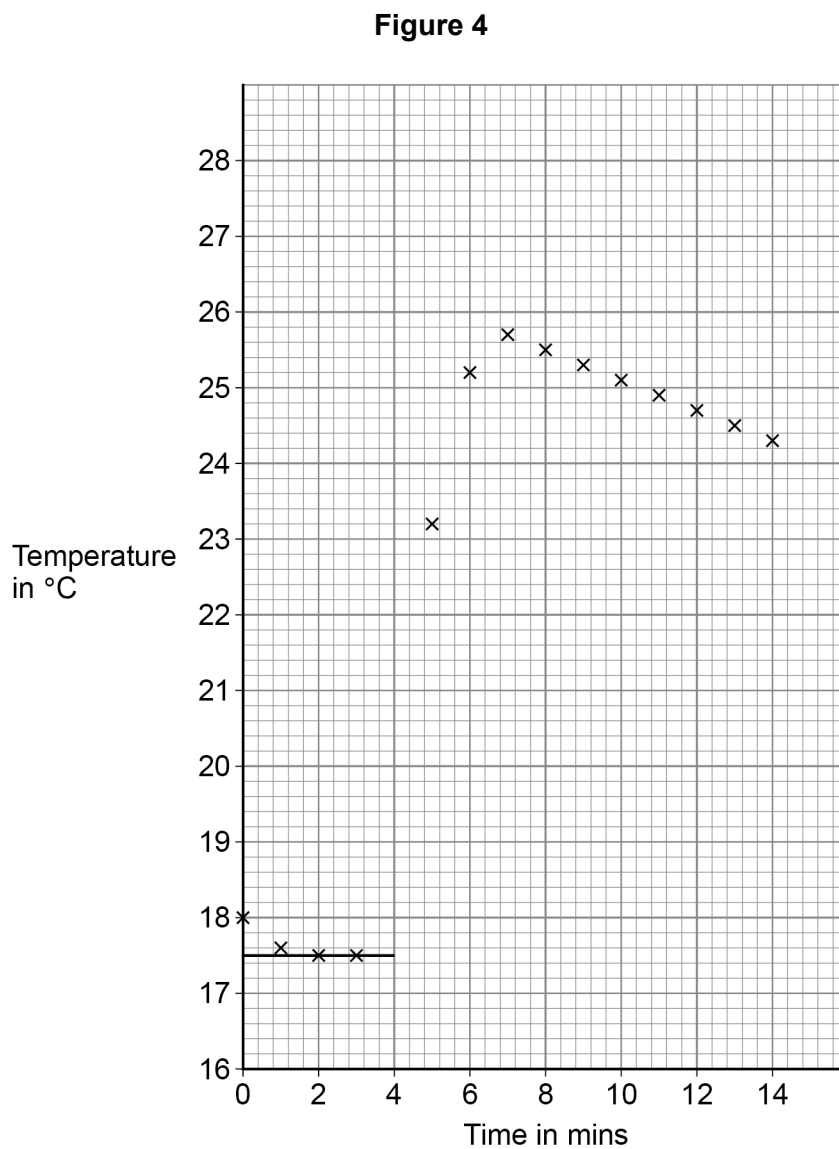
9.2

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

[1 mark]

The student used the results to plot a graph.

Figure 4 shows the graph.



9.3

Complete **Figure 4** by:

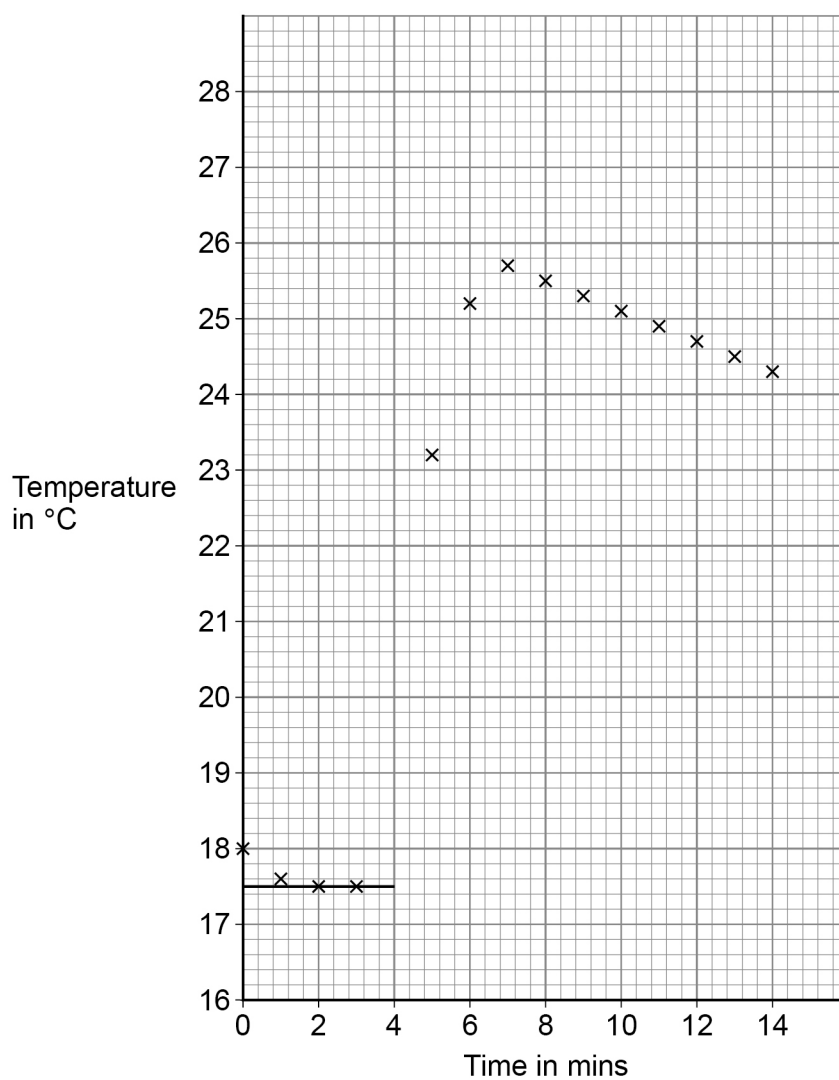
- drawing a line of best fit through all the points after 7 minutes
- extending the line back to 4 minutes.

[2 marks]

The student used the results to plot a graph.

Figure 4 shows the graph.

Figure 4



9.4

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 **Figure 4**.

[2 marks]

Temperature change = _____ °C

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

9.5

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.

[2 marks]

Metal **Q** _____

Reason _____

This question is about elements.

Caesium is in Group 1 of the periodic table.

10.1

Explain what happens to caesium atoms and to oxygen atoms when caesium reacts with oxygen to produce caesium oxide.

You should answer in terms of electrons.

[4 marks]

11.1

A student added copper metal to colourless silver nitrate solution.

The student observed:

- pale grey crystals forming
- the solution turning blue.

Explain how these observations show that silver is less reactive than copper.

[3 marks]

The metals are magnesium, iron and copper.

Your plan should give valid results.

[4 marks]

[illegible]

12.1

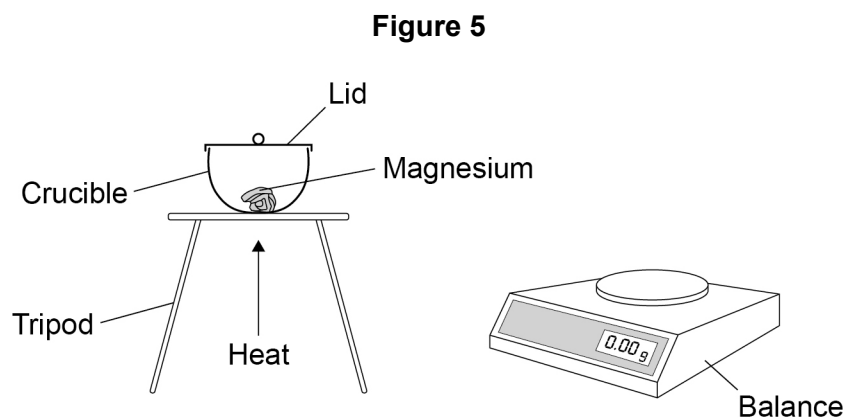
Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction.

[2 marks]

Metal oxides are produced when metals are heated in air.

A student investigated the change in mass when 0.12 g of magnesium was heated in air.

Figure 5 shows the apparatus.



The student measured the mass of magnesium oxide produced.

13.1

The student repeated the experiment **without** a lid on the crucible.

Suggest why the mass of magnesium oxide produced would be different without a lid on the crucible.

[2 marks]

13.2

Copper reacts with oxygen to produce copper oxide.

63.5 g of copper produces 79.5 g of copper oxide.

Calculate the mass of copper oxide produced when 0.50 g of copper reacts with oxygen.

Give your answer to 3 significant figures.

[3 marks]

Mass (3 significant figures) = _____ g

14.1 Tungsten (W) is a metal.

Tungsten is extracted from tungsten oxide (WO_3).

All other solid products from the extraction method must be separated from the tungsten.

Table 2 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 2

Method	Reactant	Relative cost of reactant	Products
1	Carbon	Low	Tungsten solid Carbon dioxide gas Tungsten carbide solid
2	Hydrogen	High	Tungsten solid Water vapour
3	Iron	Low	Tungsten solid Iron oxide solid

Evaluate the three possible methods for extracting tungsten from tungsten oxide.

[4 marks]

15.1

Give **two** observations you could make when a small piece of potassium is added to water.

[2 marks]

1 _____

2 _____

15.2

Complete the equation for the reaction of potassium with water.

You should balance the equation.

[2 marks]



Sodium reacts with oxygen to produce the ionic compound sodium oxide.

Oxygen is a Group 6 element.

15.3

Draw a dot and cross diagram to show what happens when atoms of sodium and oxygen react to produce sodium oxide.

[4 marks]

Diagram

15.4

Why is oxygen described as being reduced in the reaction between sodium and oxygen?

[1 mark]

16.1

Table 3 shows information about four substances.**Table 3**

Substance	Melting point in °C	Boiling point in °C	Does it conduct electricity in the solid state?	Does it conduct electricity in the liquid state?
A	−117	79	No	No
B	801	1413	No	Yes
C	1535	2750	Yes	Yes
D	1610	2230	No	No

Which substance could be a metal?

[1 mark]Tick (✓) **one** box.**A** ☐**B** ☐**C** ☐**D** ☐

16.2

A student wants to compare the reactivity of an unknown metal, **Q**, with that of zinc.

Both metals are more reactive than silver.

The student is provided with:

- silver nitrate solution
- metal **Q** powder
- zinc powder
- a thermometer
- normal laboratory equipment.

No other chemicals are available.

Describe a method the student could use to compare the reactivity of metal **Q** with that of zinc.

Your method should give valid results.

[4 marks]

17.1

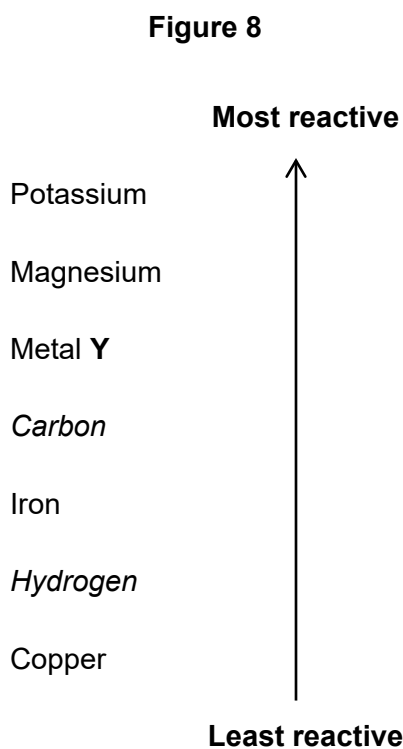
Plan an investigation to find the order of reactivity of three metals.

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

[6 marks]

[illegible]

18.1

Figure 8 shows a reactivity series.

Give the method and conditions used to extract metal **Y** from a compound of metal **Y**.

[2 marks]

Sodium reacts with titanium chloride (TiCl_4) to produce titanium.

18.2

Complete the equation.

You should balance the equation.

[2 marks]



19.1

Name the type of bonding in compounds formed between metals and non-metals.

[1 mark]

19.2

Magnesium oxide is a compound formed from the metal magnesium and the non-metal oxygen.

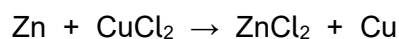
Describe what happens when a magnesium atom reacts with an oxygen atom.

You should refer to electrons in your answer.

[4 marks]

Zinc chloride is also produced in a displacement reaction between zinc and copper chloride solution.

The equation for the reaction is:



20.1

Why is zinc described as being oxidised in this reaction?

[1 mark]

This question is about groups in the periodic table.

The elements in Group 1 become more reactive going down the group.

Rubidium is below potassium in Group 1.

21.1

Rubidium and potassium are added to water.

Predict **one** observation you would see that shows that rubidium is more reactive than potassium.

[1 mark]

21.2

Complete the equation for the reaction of rubidium with water.

You should balance the equation.

[3 marks]

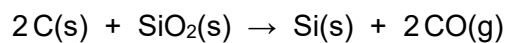


22.1

The reactivity series sometimes includes non-metals such as carbon, hydrogen and silicon.

Silicon can be extracted by reducing silicon dioxide with different substances.

The equation for one possible reaction is:



Explain what this reaction shows about the position of silicon in the reactivity series.

[2 marks]

22.2

Aluminium also reduces silicon dioxide.

Carbon is used rather than aluminium to reduce silicon dioxide because carbon is cheaper than aluminium.

Carbon can be obtained by heating coal.

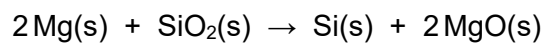
Aluminium is obtained from aluminium oxide.

Explain why aluminium is more expensive than carbon.

[2 marks]

Magnesium also reduces silicon dioxide.

The equation for the reaction is:



22.3

Give **one** reason why the products are difficult to separate if magnesium is used to reduce silicon dioxide.

[1 mark]

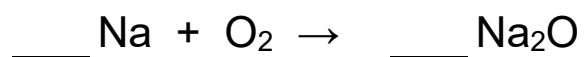
Sodium is in Group 1 of the periodic table.

Sodium reacts with oxygen to produce sodium oxide.

23.1

Balance the equation for the reaction.

[1 mark]



23.2

Explain what happens to sodium atoms and to oxygen atoms when sodium reacts with oxygen to produce sodium oxide (Na_2O).

Answer in terms of electrons.

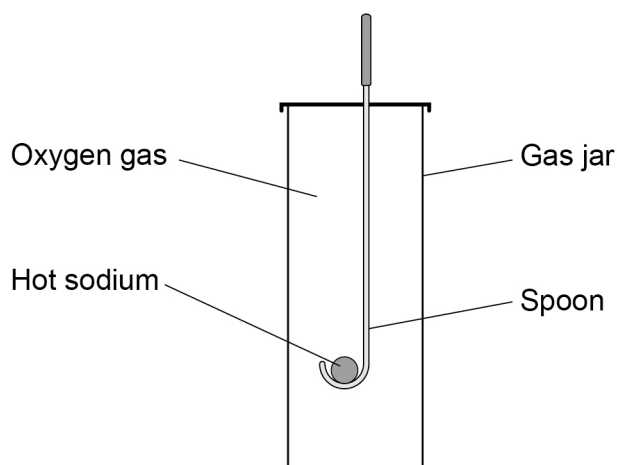
[4 marks]

23.3

Sodium burns in a gas jar of oxygen.

Figure 3 shows the apparatus.

Figure 3



Give **two** observations seen during the reaction.

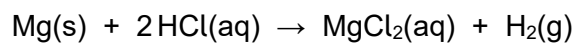
[2 marks]

- 1 _____
- 2 _____

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:



24.1

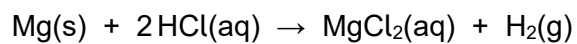
Describe how solid magnesium chloride is obtained from the reaction mixture.

[2 marks]

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:



24.2

The reaction between magnesium and hydrochloric acid is a redox reaction.

Explain what happens to the magnesium atoms in this reaction.

[2 marks]

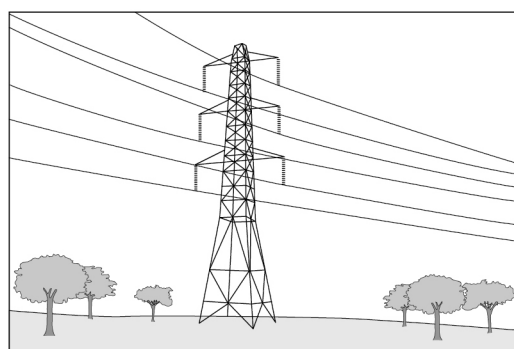
This question is about uses of metals in electrical wires.

Electrical wires can be made from:

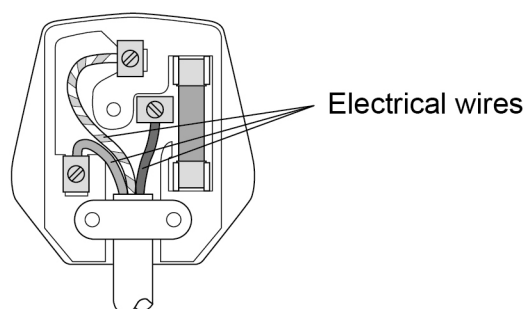
- aluminium
- copper
- silver.

Figure 6 shows three uses of electrical wires.

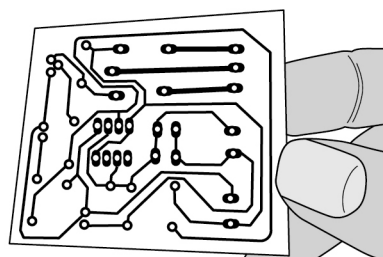
Figure 6



Overhead power cables



Wiring in homes



Printed circuit boards

Table 5 shows information about the metals.

The higher the value for electrical conductivity, the better the metal is at conducting electricity.

Table 5

	Aluminium	Copper	Silver
Electrical conductivity in arbitrary units	37.7	59.6	63.0
Density in g/cm ³	2.7	9.0	10.5
Cost of metal per kg in £	1.50	7.00	640.00

25.1

Evaluate the use of aluminium, copper and silver for the types of electrical wires shown in **Figure 6**.

Use **Table 5**.

[4 marks]

Barium (Ba) is an element in Group 2 of the periodic table.

Barium reacts with hydrochloric acid.

26.1

Suggest **two** observations that could be made when barium reacts with hydrochloric acid.

[2 marks]

1 _____

2 _____

Barium (Ba) is an element in Group 2 of the periodic table.

Barium reacts with hydrochloric acid.

26.2

Write a balanced symbol equation for the reaction between barium and hydrochloric acid.

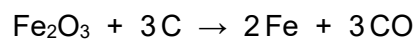
[3 marks]

_____ + _____ → _____ + _____

This question is about displacement reactions.

Iron is extracted from iron oxide by a displacement reaction with carbon.

The equation for the reaction is:



27.1

Which substance in the equation is reduced?

Give **one** reason for your answer.

Answer in terms of oxygen.

[2 marks]

Substance reduced _____

Reason _____

A student investigated displacement reactions of four different metals represented by **A**, **B**, **C** and **D**.

A, **B**, **C** and **D** are **not** the actual chemical symbols for the metals.

The student:

- added each metal to aqueous solutions of the metal nitrates
- observed whether a reaction took place.

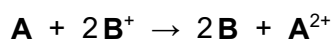
Table 6 shows information about three of the reaction mixtures.

Table 6

Reaction	Metal	Metal nitrate solution	Equation
1	A	BNO₃	A + 2BNO₃ → 2B + A(NO₃)₂
2	C	A(NO₃)₂	2C + 3A(NO₃)₂ → 3A + 2C(NO₃)₃
3	C	D(NO₃)₂	no reaction

27.2

The ionic equation for **Reaction 1** is:



Why is this a redox reaction?

[1 mark]

Tick (✓) **one** box.

A gains electrons and **B⁺** loses electrons.

☐

A loses electrons and **B⁺** gains electrons.

☐

Both **A** and **B⁺** gain electrons.

☐

Both **A** and **B⁺** lose electrons.

☐

A student investigated displacement reactions of four different metals represented by **A**, **B**, **C** and **D**.

A, **B**, **C** and **D** are **not** the actual chemical symbols for the metals.

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Table 6

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1	A	BNO₃	A + 2 BNO₃ → 2 B + A(NO₃)₂
2	C	A(NO₃)₂	2 C + 3 A(NO₃)₂ → 3 A + 2 C(NO₃)₃
3	C	D(NO₃)₂	no reaction

27.3

Which of the four metals has the greatest tendency to form positive ions?

Use **Table 6**.

[1 mark]

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐