1 (a) Drinks are often sold in cans.
These cans are made either of aluminium or of steel coated with tin.
The table gives information about these three metallic substances.

metal	cost of 1 kg / £	amount in Earth's crust / %
aluminium	1.31	8
steel (iron)	0.32	5
tin	12.6	0.0002

Use the table to give **two** reasons why it could be more important to recycle tin than to recycle aluminium or steel.

(2)

reason 1

.....

.....

reason 2

.....

.....

(b) Complete the sentence by putting a cross (☒) in the box next to your answer.

The reaction for the extraction of aluminium from its ore involves

(1)

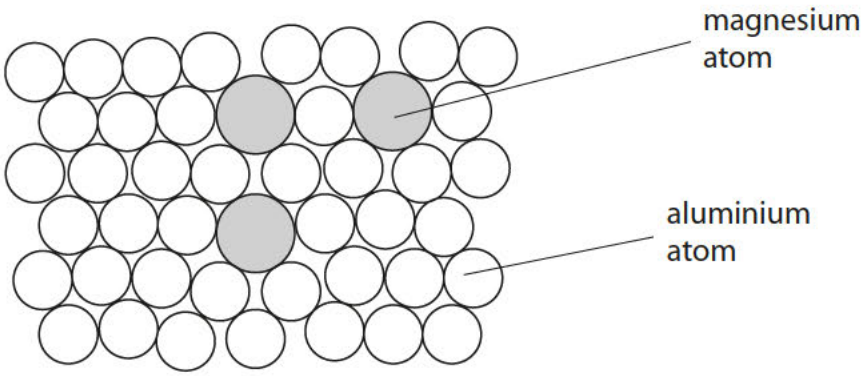
☐ **A** heating with carbon

☐ **B** thermal decomposition

☐ **C** reduction

☐ **D** neutralisation

(c) Magnalium is an alloy of aluminium and magnesium.
The diagram shows the structure of this alloy.



(i) Explain what you understand by the term **alloy**.

(2)

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(ii) Explain, in terms of their structures, why magnalium is stronger than pure aluminium.

(3)

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(Total for Question 1 = 8 marks)

2 The list shows some metals in reactivity series order with the most reactive at the top.

most reactive	calcium
	magnesium
	aluminium
	zinc
	iron
	copper
least reactive	gold

(a) Which of these metals can be found as the uncombined metal in the Earth's crust?

Put a cross (☒) in the box next to your answer.

(1)

- ☐ **A** calcium
- ☐ **B** gold
- ☐ **C** magnesium
- ☐ **D** zinc

(b) Metals are extracted by the reduction of their ores.

State the meaning of the term **reduction**.

(1)

.....

.....

(c) Aluminium is extracted by the electrolysis of a molten mixture of its ore (bauxite) and cryolite.
Iron is extracted by heating a mixture of its ore and carbon.

Explain why electrolysis is used to extract aluminium but is not used to extract iron.

(2)

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.....

(d) An alloy of aluminium with magnesium is used for parts of aeroplanes.



Explain why the aluminium alloy is stronger than pure aluminium.

(2)

.....

.....

.....

.....

(e) When aluminium corrodes, it reacts with oxygen to form aluminium oxide, Al_2O_3.

Complete the balancing of this equation by putting numbers in the spaces provided.

(2)

..... Al + ... O_2 → $2Al_2O_3$

(Total for Question 2 = 8 marks)

3 A student carried out an experiment to see how reactive different metals are when they are placed in dilute hydrochloric acid.

A sample of each metal was placed in a separate test tube of acid.

(a) When zinc reacts with dilute hydrochloric acid, a gas is given off and zinc chloride is formed.

(i) Which gas is given off?

☒ **A** carbon dioxide

☒ **B** chlorine

☒ **C** hydrogen

☒ **D** oxygen

(1)

(ii) What is the formula of zinc chloride?

☒ **A** ZnCl

☒ **B** Zn_2Cl

☒ **C** $ZnCl_2$

☒ **D** Zn_2Cl_2

(1)

(b) In the experiment, the student used the same amount of each metal in a finely powdered form.

State **two** factors, concerning the hydrochloric acid, which should also be controlled to produce valid results.

(2)

1 .....

.....

2 .....

.....

(c) Part of the reactivity series is shown in Figure 8.

most reactive	magnesium
	aluminium
	iron
least reactive	silver

Figure 8

Iron is extracted from its ore by heating with carbon.
Aluminium is extracted from its ore using a different method.

(i) Give the name of the method used to extract aluminium.

(1)

.....

(ii) Explain why aluminium is extracted by a different method rather than heating the ore with carbon.

(2)

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(d) The extraction of iron involves the reduction of iron oxide, Fe_2O_3, by carbon monoxide, CO. During this reaction, the iron oxide is reduced to iron, Fe, and the carbon monoxide is oxidised to carbon dioxide.

Write the balanced equation for the reaction.

(2)

.....

(Total for Question 3 = 9 marks)

4 The list shows some metals in order of reactivity.

most reactive	sodium
	aluminium
	zinc
	iron
	copper
least reactive	gold

(a) Aluminium and iron are extracted by reduction of their oxides.

State what is meant by reduction.

(1)

.....

.....

(b) Electrolysis and heating with carbon are two methods of reduction.

Explain why aluminium needs to be extracted from its ore by electrolysis, rather than by heating with carbon.

(2)

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.....

(c) Iron is extracted from iron oxide, Fe_2O_3.

In the extraction process the iron oxide is heated with carbon to form iron and carbon dioxide.

Write the balanced equation for this reaction.

(3)

.....

*(d) Pure metal can be converted into alloys.

In many cases alloys are more useful than pure metals, for example they are stronger. Gold alloys, stainless steel and nitinol are examples of useful alloys.

Describe how alloying improves the usefulness of metals and how strength is increased in terms of structure.

You may use diagrams to help your answer.

(6)

(Total for Question 4 = 12 marks)

5 (a) In the extraction of tin from tin oxide, tin oxide is heated with carbon.

$$SnO_2 + C \rightarrow Sn + CO_2$$

Complete the sentence by putting a cross (☒) in the box next to your answer.

When the tin oxide reacts with carbon to form the products

(1)

- ☐ **A** tin is oxidised
- ☐ **B** tin oxide is reduced
- ☐ **C** carbon is reduced
- ☐ **D** carbon dioxide is oxidised

(b) Pure gold is too soft to be used for some jewellery.

(i) Gold alloys contain other metals such as copper and silver.

In terms of the arrangement of metal atoms, explain why gold alloys are stronger than pure gold.

(2)

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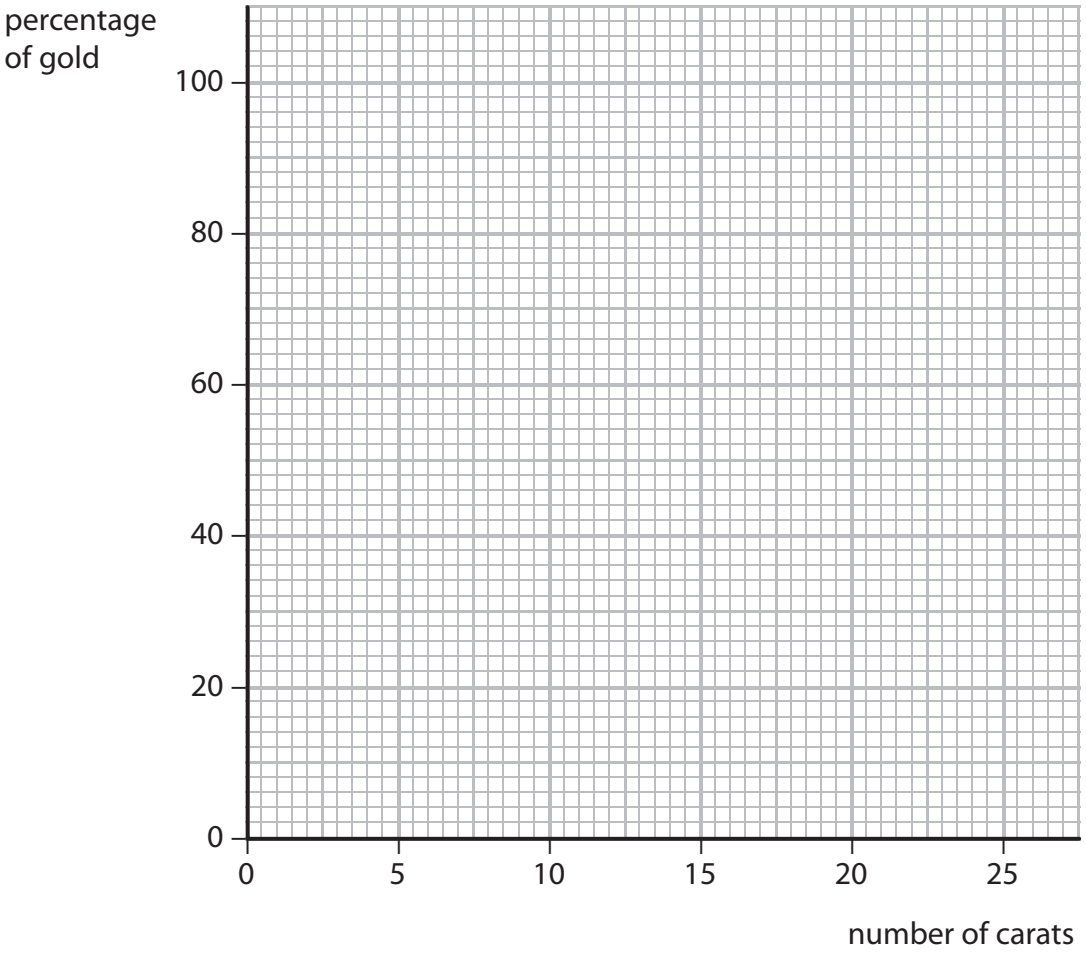
(ii) The purity of gold is often measured in carats.

The data shows how the number of carats is related to the percentage of gold.

number of carats	percentage of gold
24	100
22	92
18	75
9	38

On the grid provided, draw a graph of the percentage of gold against the number of carats.

(2)



(iii) A gold ring is 14 carat gold.

Use the graph to determine the percentage of gold in the ring.

(1)

*(c) Metals are obtained from the Earth's crust by different methods.

Some metals are found uncombined but others have to be extracted from their ores by electrolysis or by heating the ore with carbon.

Explain, using aluminum, gold and iron as examples, how the method used to obtain the metal is related to its position in the reactivity series and to the cost of the extraction process.

(6)

(Total for Question 5 = 12 marks)