

1

A student investigated the reactivity of three different metals.

This is the method used.

1. Place 1 g of metal powder in a test tube.
2. Add 10 cm<sup>3</sup> of metal sulfate.
3. Wait 1 minute and observe.
4. Repeat using the other metals and metal sulfates.

The student placed a tick in the table below if there was a reaction and a cross if there was no reaction.

	Zinc	Copper	Magnesium
Copper sulfate	✓	x	✓
Magnesium sulfate	x	x	x
Zinc sulfate	x	x	✓

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

Tick **one** box.

Time taken

Type of metal

Volume of metal sulfate

Whether there was a reaction or not

(1)

(b) Give **one** observation the student could make that shows there is a reaction between zinc and copper sulfate.

.....

.....

(1)

- (c) The student used measuring instruments to measure some of the variables.

Draw **one** line from each variable to the measuring instrument used to measure the variable.

Variable	Measuring instrument
	Balance
Mass of metal powder	Measuring cylinder
	Ruler
Volume of metal sulfate	Burette
	Thermometer
	Test tube

(2)

- (d) Use the results shown in table above to place zinc, copper and magnesium in order of reactivity.

Most reactive .....



Least reactive .....

(1)

- (e) Suggest **one** reason why the student should **not** use sodium in this investigation.

.....  
 .....

(1)

(f) Which metal is found in the Earth as the metal itself?

Tick **one** box.

Calcium

Gold

Lithium

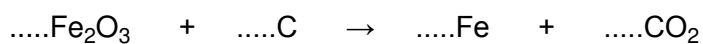
Potassium

(1)

(g) Iron is found in the Earth as iron oxide ( $\text{Fe}_2\text{O}_3$ ).

Iron oxide is reduced to produce iron.

Balance the equation for the reaction.



(1)

(h) Name the element used to reduce iron oxide.

.....

(1)

(i) What is meant by reduction?

Tick **one** box.

Gain of iron

Gain of oxide

Loss of iron

Loss of oxygen

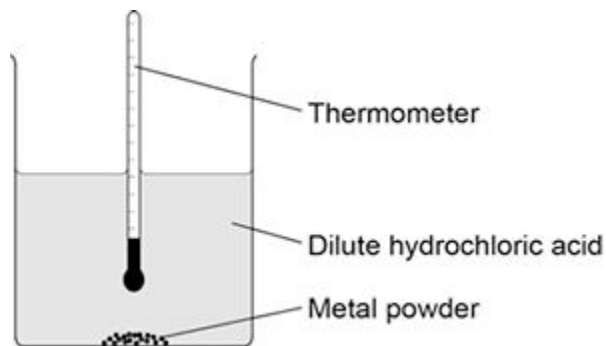
(1)

(Total 10 marks)

2

A student investigated the reactivity of different metals.

The student used the apparatus shown in the figure below.



The student used four different metals.

The student measured the temperature rise for each metal three times.

The student's results are shown in the table below.

Metal	Temperature rise in °C			Mean temperature rise in °C
	Test 1	Test 2	Test 3	
Calcium	17.8	16.9	17.5	
Iron	6.2	6.0	6.1	6.1
Magnesium	12.5	4.2	12.3	12.4
Zinc	7.8	8.0	7.6	7.8

(a) Give **two** variables the student should control so that the investigation is a fair test.

1 .....

.....

2 .....

.....

(2)

(b) One of the results for magnesium is anomalous.

Which result is anomalous?

Suggest **one** reason why this anomalous result was obtained.

Result .....

.....

Reason .....

.....

(2)

(c) Calculate the mean temperature rise for calcium.

.....

Mean temperature rise = ..... °C

(1)

(d) The temperature rose when the metals were added to sulfuric acid.

Give **one** other observation that might be made when the metal was added to sulfuric acid.  
How would this observation be different for the different metals?

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(2)

(e) Aluminium is more reactive than iron and zinc but less reactive than calcium and magnesium.

Predict the temperature rise when aluminium is reacted with dilute hydrochloric acid.

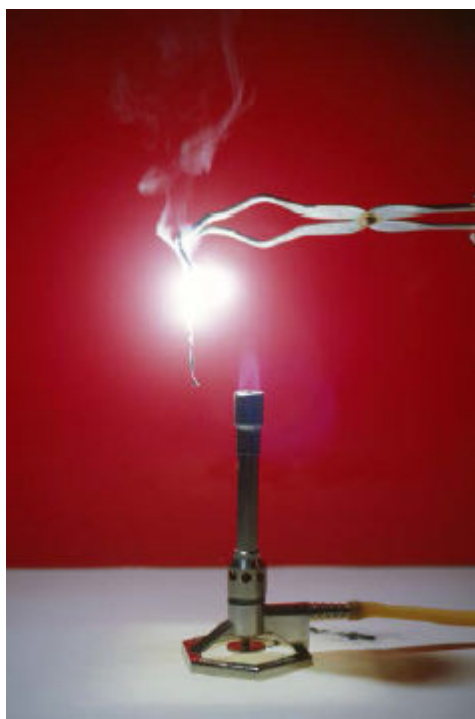
.....

Temperature rise = ..... °C

(1)

(Total 8 marks)

**3** The figure below shows magnesium burning in air.



© Charles D Winters/Science Photo Library

(a) Look at the figure above.

How can you tell that a chemical reaction is taking place?

.....  
.....

(1)

(b) Name the product from the reaction of magnesium in the figure.

.....

(1)

- (c) The magnesium needed heating before it would react.

What conclusion can you draw from this?

Tick **one** box.

The reaction is reversible

The reaction has a high activation energy

The reaction is exothermic

Magnesium has a high melting point

(1)

- (d) A sample of the product from the reaction in the figure above was added to water and shaken.

Universal indicator was added.

The universal indicator turned blue.

What is the pH value of the solution?

Tick **one** box.

1

4

7

9

(1)

(e) Why are nanoparticles effective in very small quantities?

Tick **one** box.

They are elements

They are highly reactive

They have a low melting point

They have a high surface area to volume ratio

(1)

(f) Give **one** advantage of using nanoparticles in sun creams.

.....  
.....

(1)

(g) Give **one** disadvantage of using nanoparticles in sun creams.

.....  
.....

(1)

(h) A coarse particle has a diameter of  $1 \times 10^{-6}$  m.  
A nanoparticle has a diameter of  $1.6 \times 10^{-9}$  m.

Calculate how many times bigger the diameter of the coarse particle is than the diameter of the nanoparticle.

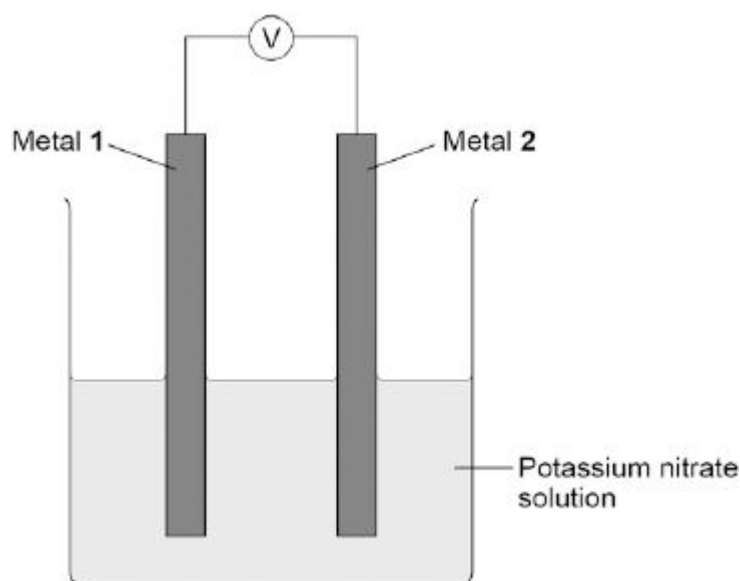
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(2)  
(Total 9 marks)



4

A student investigated simple cells using the apparatus shown in the figure below.

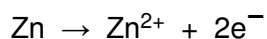


- If metal 2 is more reactive than metal 1 then the voltage measured is positive.
- If metal 1 is more reactive than metal 2 then the voltage measured is negative.
- The bigger the difference in reactivity of the two metals, the larger the voltage produced.

The student's results are shown in the table below.

Metal 1 \ Metal 2	Chromium	Copper	Iron	Tin	Zinc
Chromium	0.0 V				
Copper	1.2 V	0.0 V			
Iron	0.5 V	not measured	0.0 V		
Tin	0.8 V	-0.4 V	0.3 V	0.0 V	
Zinc	0.2 V	-1.0 V	-0.3 V	-0.6 V	0.0 V

- (a) The ionic equation for the reaction occurring at the zinc electrode in the simple cell made using copper and zinc electrodes is:



Zinc is oxidised in this reaction.

Give a reason why this is oxidation.

.....  
 .....

(b) Look at the table above.

Which **one** of the metals used was the least reactive?

Give a reason for your answer.

Metal .....

Reason .....

.....

.....

(2)

(c) Predict the voltage that would be obtained for a simple cell that has iron as metal **1** and copper as metal **2**.

Explain your answer.

.....

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(3)

(d) Hydrogen fuel cells have been developed for cars.

Write a word equation for the overall reaction that takes place in a hydrogen fuel cell.

.....

(1)

- (e) Write the **two** half equations for the reactions that occur at the electrodes in a hydrogen fuel cell.

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.....

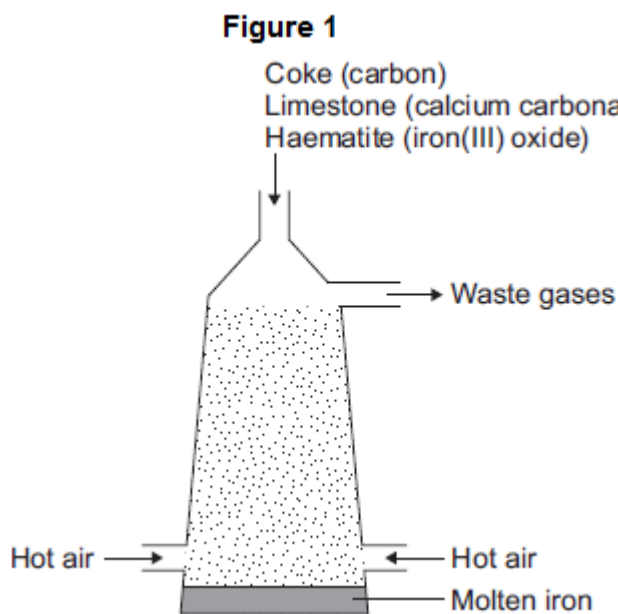
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(2)  
(Total 9 marks)

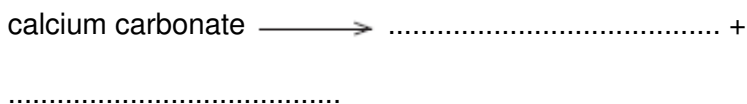
**5** This question is about iron and aluminium.

- (a) Iron is extracted in a blast furnace. **Figure 1** is a diagram of a blast furnace.



- (i) Calcium carbonate decomposes at high temperatures.

Complete the word equation for the decomposition of calcium carbonate.



(2)

- (ii) Carbon burns to produce carbon dioxide.

The carbon dioxide produced reacts with more carbon to produce carbon monoxide.

Balance the equation.



(1)

- (iii) Carbon monoxide reduces iron(III) oxide:



Calculate the maximum mass of iron that can be produced from 300 tonnes of iron(III) oxide.

Relative atomic masses ( $A_r$ ): O = 16; Fe = 56

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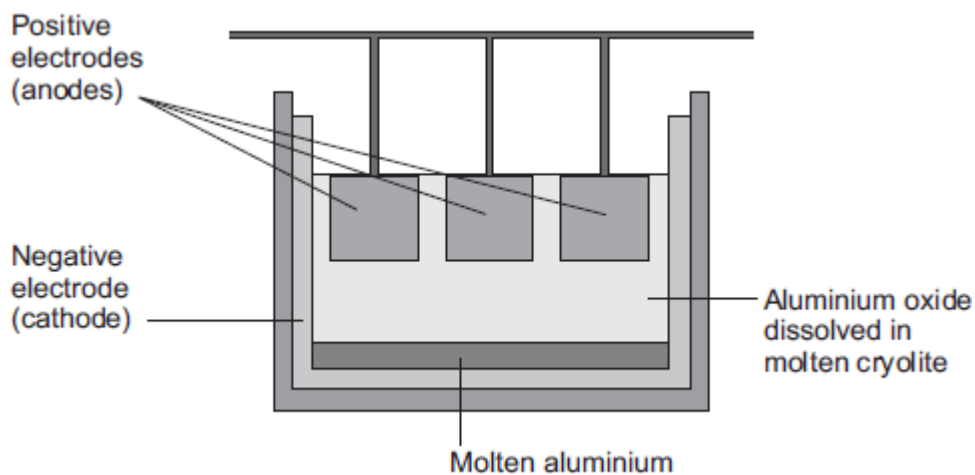
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Maximum mass = ..... tonnes

(3)

- (b) Aluminium is extracted by electrolysis, as shown in
- Figure 2**
- .

**Figure 2**



- (i) Why can aluminium
- not**
- be extracted by heating aluminium oxide with carbon?

.....

.....

(1)

(ii) Explain why aluminium forms at the negative electrode during electrolysis.

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(3)

(iii) Explain how carbon dioxide forms at the positive electrodes during electrolysis.

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(3)  
(Total 13 marks)

6

This question is about metals.

(a) Which unreactive metal is found in the Earth as the metal itself?

Tick (✓) **one** box.

aluminium	<input type="checkbox"/>
gold	<input type="checkbox"/>
magnesium	<input type="checkbox"/>

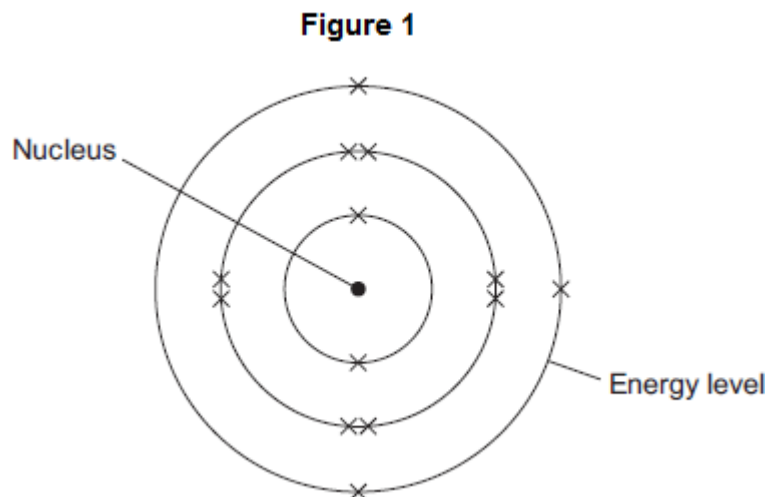
(1)

- (b) Complete the sentence.

Aluminium is an element because aluminium is made of  
only one type of .....

(1)

- (c) **Figure 1** shows the electronic structure of an aluminium atom.



- (i) Use the correct words from the box to complete the sentence.

<b>electrons</b>	<b>ions</b>	<b>protons</b>	<b>neutrons</b>	<b>shells</b>
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The nucleus of an aluminium atom contains ..... and  
.....

(2)

- (ii) Complete the sentence.

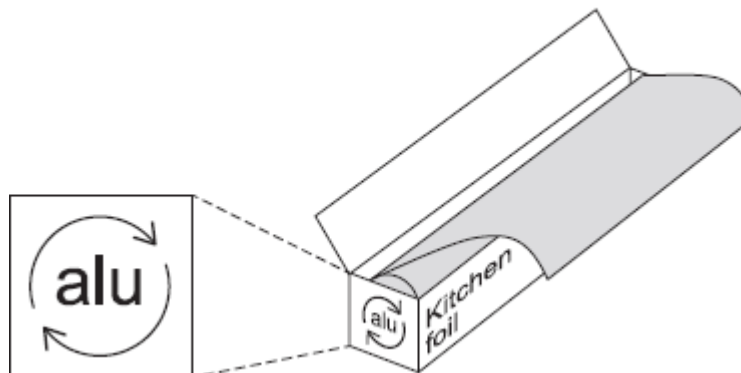
In the periodic table, aluminium is in Group .....

(1)

- (d) Aluminium is used for kitchen foil.

**Figure 2** shows a symbol on a box of kitchen foil.

**Figure 2**



The symbol means that aluminium can be recycled. It does not show the correct chemical symbol for aluminium.

- (i) What is the correct chemical symbol for aluminium?

.....

(1)

- (ii) Give **two** reasons why aluminium should be recycled.

.....

.....

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(2)

- (e) Aluminium has a low density, conducts electricity and is resistant to corrosion.

Which **one** of these properties makes aluminium suitable to use as kitchen foil?

Give a reason for your answer.

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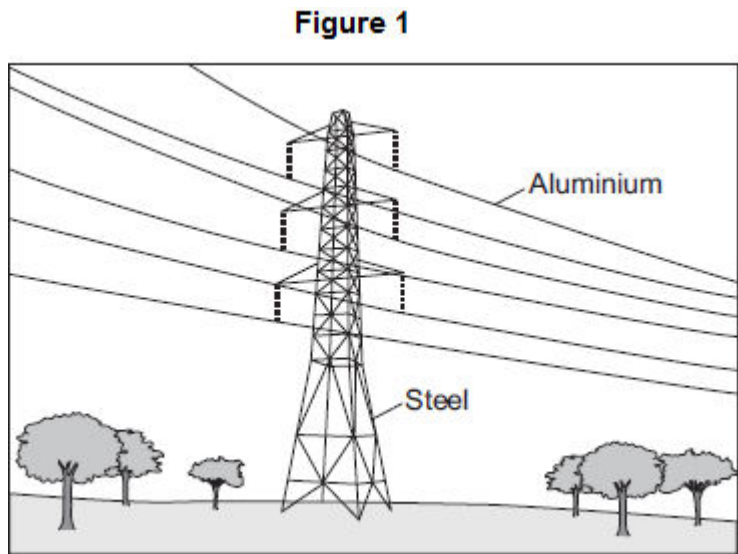
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(2)  
(Total 10 marks)

7

This question is about metals.

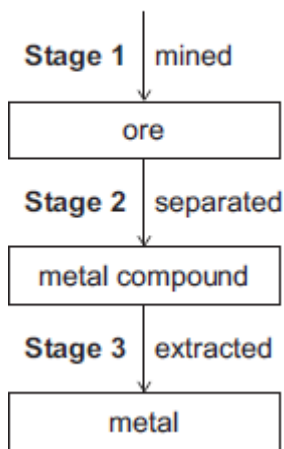
**Figure 1** shows the metals used to make pylons and the wires of overhead cables.



(a) An ore contains a metal compound.

A metal is extracted from its ore in three main stages, as shown in **Figure 2**.

**Figure 2**



Explain why **Stage 2** needs to be done.

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.....

.....

.....

(2)



(b) Cast iron from a blast furnace contains 96% iron and 4% carbon.

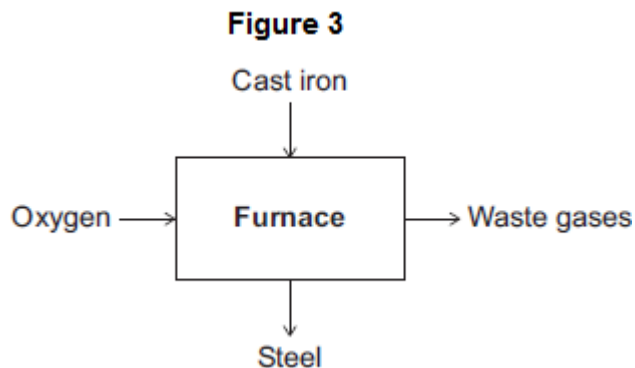
(i) Cast iron is not suitable for the manufacture of pylons.

Give **one** reason why.

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(1)

(ii) Most cast iron is converted into steel, as shown in **Figure 3**.



Describe how cast iron is converted into steel.

Use **Figure 3** to help you to answer this question.

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(2)

(c) Aluminium and copper are good conductors of electricity.

(i) State **one** property that makes aluminium more suitable than copper for overhead cables.

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(1)

(ii) How can you tell that copper is a transition metal and aluminium is **not** a transition metal from the position of each metal in the periodic table?

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(2)

(iii) Copper can be extracted from solutions of copper salts by adding iron.

Explain why.

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(2)

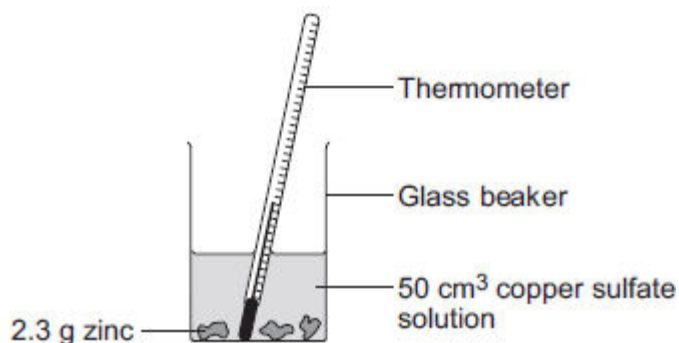
(Total 10 marks)

8

A student investigated the temperature change when zinc reacts with copper sulfate solution.

The student used a different concentration of copper sulfate solution for each experiment.

The student used the apparatus shown below.



The student:

- measured 50 cm<sup>3</sup> copper sulfate solution into a glass beaker
- measured the temperature of the copper sulfate solution
- added 2.3 g zinc
- measured the highest temperature
- repeated the experiment using copper sulfate solution with different concentrations.

The equation for the reaction is:



(a) The thermometer reading changes during the reaction.

Give **one** other change the student could **see** during the reaction.

.....  
 .....

(1)

(b) Suggest **one** improvement the student could make to the apparatus.

Give a reason why this improves the investigation.

Improvement .....

.....

Reason .....

.....

(2)

- (c) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

The student's results are shown in the table.

Table

Experiment number	Concentration of copper sulfate in moles per dm <sup>3</sup>	Increase in temperature in °C
1	0.1	5
2	0.2	10
3	0.3	12
4	0.4	20
5	0.5	25
6	0.6	30
7	0.7	35
8	0.8	35
9	0.9	35
10	1.0	35

Describe **and** explain the trends shown in the student's results.

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(6)  
(Total 9 marks)

9

Iron is extracted from iron oxide in the blast furnace.

(a) The equation for one of the reactions in the blast furnace is:



(i) Complete the word equation for this reaction.



(ii) Oxygen is removed from iron oxide in the blast furnace.

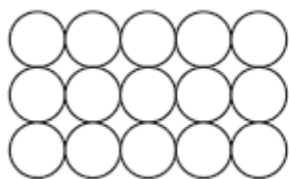
Draw a ring around the correct answer to complete the sentence.

The iron oxide is

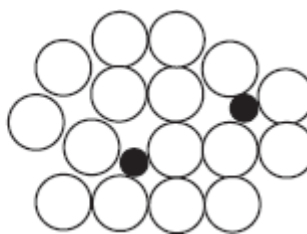
neutralised.
oxidised.
reduced.

**(1)**

(b) The diagrams represent pure iron and iron from the blast furnace.



Pure iron



Iron from the blast furnace

(i) Draw **one** line from each statement to the correct explanation.

**Statement**

**Explanation**

Pure iron is an element because .....

it is made of one sort of atom only.

it contains two elements not chemically combined.

Iron from the blast furnace is a mixture because .....

every atom has the same number of neutrons.

it contains two elements chemically combined.

(2)

(ii) Explain why iron from the blast furnace is harder than pure iron.

Use the diagrams on page 4 to help you.

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(2)  
(Total 7 marks)

**10**

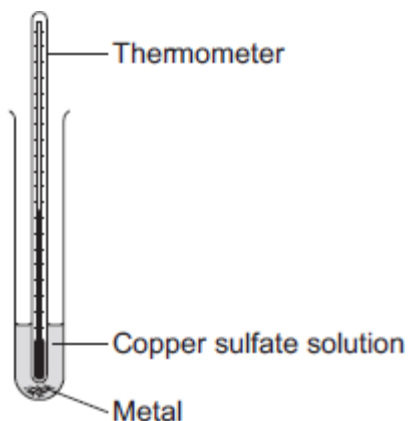
A student investigated displacement reactions of metals.

The student added different metals to copper sulfate solution and measured the temperature change.

The more reactive the metal is compared with copper, the bigger the temperature change.

The apparatus the student used is shown in **Figure 1**.

**Figure 1**



(a) State **three** variables that the student must control to make his investigation a fair test.

1 .....

2 .....

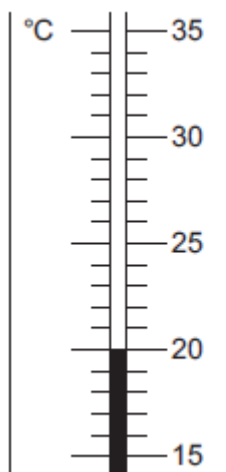
3 .....

**(3)**

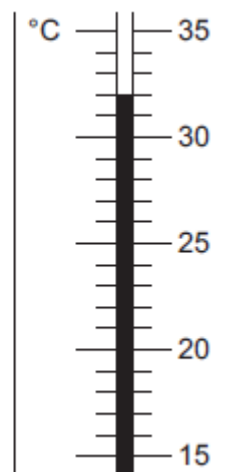
- (b) **Figure 2** shows the thermometer in one experiment before and after the student added a metal to the copper sulfate solution.

**Figure 2**

**Before adding metal**



**After adding metal**



Use **Figure 2** to complete **Table 1**.

**Table 1**

Temperature before adding metal in °C	.....
Temperature after adding metal in °C	.....
Change in temperature in °C	.....

**(3)**



- (c) The student repeated the experiment three times with each metal.

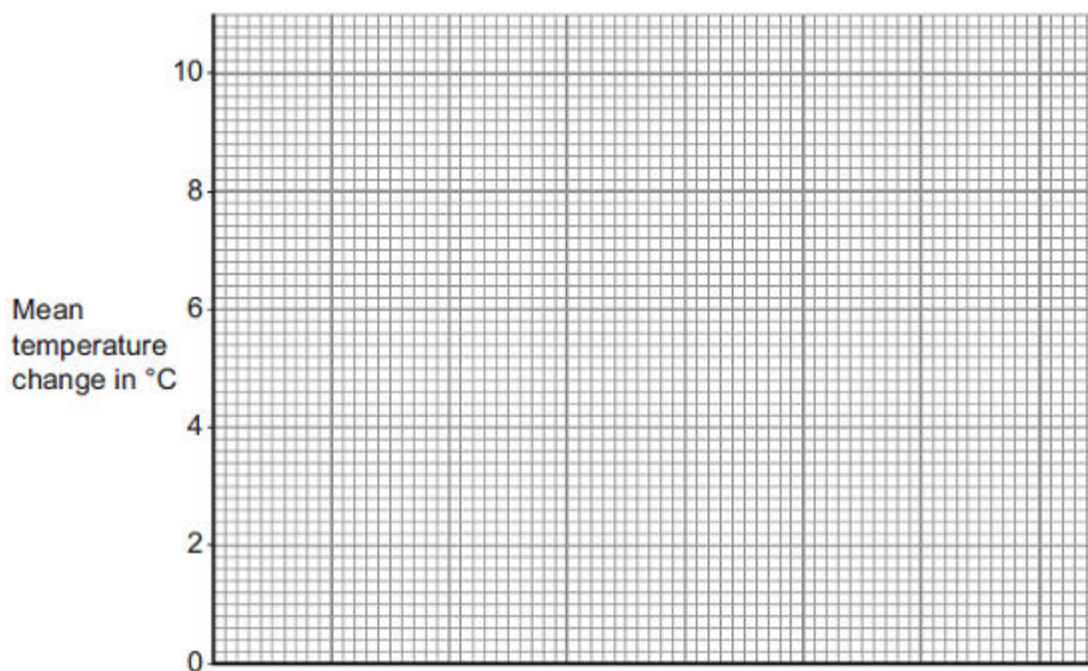
**Table 2** shows the mean temperature change for each metal.

**Table 2**

<b>Metal</b>	<b>Mean temperature change in °C</b>
Cobalt	4.5
Gold	0.0
Magnesium	10.0
Nickel	3.0
Silver	0.0
Tin	1.5

- (i) On **Figure 3**, draw a bar chart to show the results.

**Figure 3**



(3)

- (ii) Why is a line graph **not** a suitable way of showing the results?

.....  
 .....

(1)

(iii) Use the results to work out which metal is the most reactive.

Give a reason for your answer.

Most reactive metal .....

Reason .....

.....

(2)

(iv) Explain why there was no temperature change when silver metal was added to the copper sulfate solution.

.....

.....

.....

.....

(2)

(v) It is **not** possible to put all six metals in order of reactivity using these results.

Suggest how you could change the experiment to be able to put all six metals into order of reactivity.

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.....

(2)

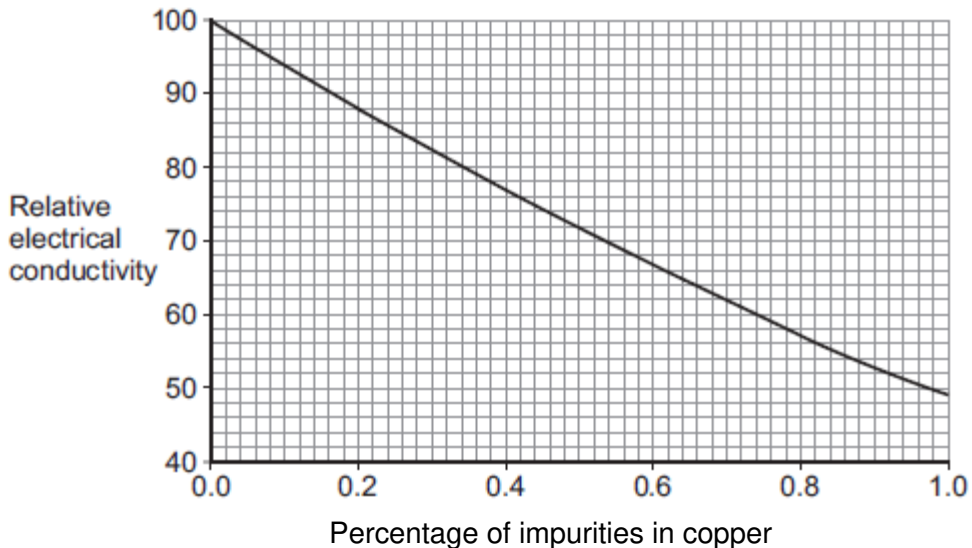
(Total 16 marks)

11

This question is about copper.

- (a) Most of the copper extracted is used in electric circuits.

The figure below shows how impurities change the electrical conductivity of copper.



Copper extracted by smelting is about 99% pure.

The 99% pure copper produced by smelting is purified to 99.9999% pure copper by electrolysis.

Use values from the graph to explain why copper is purified to 99.9999%.

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(2)



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Extra space .....  
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**(6)**

- (c) Phytomining is used to obtain copper from land that contains very low percentages of copper compounds.

Describe how copper compounds are obtained by phytomining.

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**(3)**

**(Total 11 marks)**

12

Where copper ore has been mined there are areas of land that contain very low percentages of copper compounds.

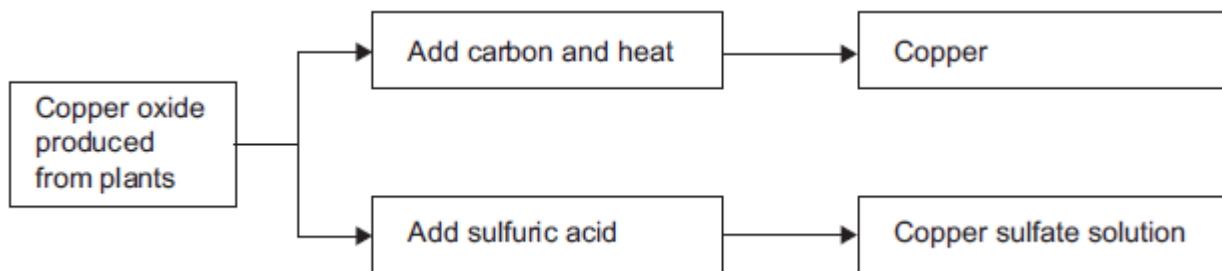
One way to extract the copper is to grow plants on the land.

The plants absorb copper compounds through their roots.

The plants are burned to produce copper oxide.

The copper oxide produced from plants can be reacted to produce copper or copper sulfate solution, as shown in **Figure 1**.

**Figure 1**



(a) Draw a ring around the correct answer to complete each sentence.

(i) Copper ores contain enough copper to make extraction of the metal

carbon neutral.  
economical.  
reversible.

(1)

(ii) Using plants to extract metals is called

photosynthesis.  
phytomining.  
polymerisation.

(1)

(iii) Copper oxide reacts with carbon to produce copper and

carbon dioxide.  
oxygen.  
sulfur dioxide.

(1)

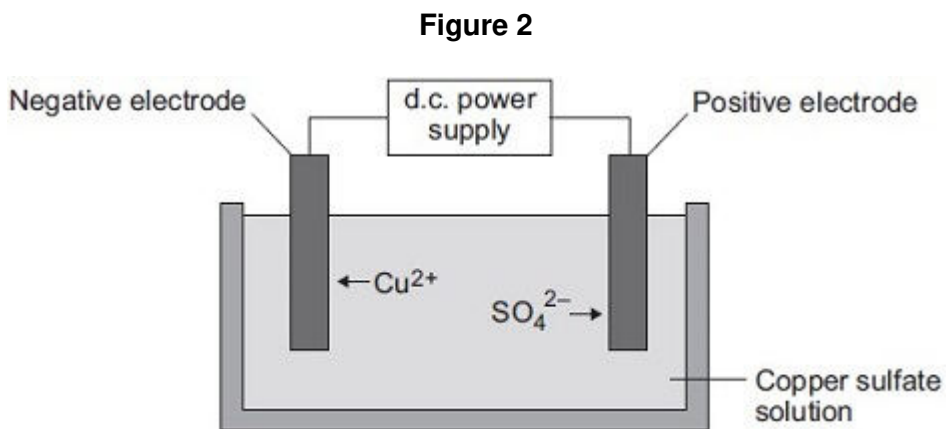
(b) Copper is produced from copper sulfate solution by displacement using iron or by electrolysis.

(i) Complete the word equation.

copper sulfate + iron  $\longrightarrow$  ..... + .....

(2)

(ii) **Figure 2** shows the electrolysis of copper sulfate solution.



Why do copper ions go to the negative electrode?

.....

.....

(1)

(c) Suggest **two** reasons why copper should **not** be disposed of in landfill sites.

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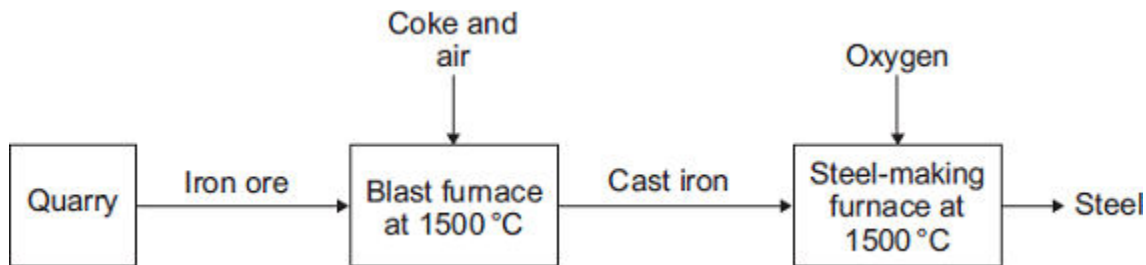
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(2)  
(Total 8 marks)

**13**

The iron produced from iron ore in a blast furnace is called cast iron.

Cast iron is converted into steel in a furnace.



Iron ore contains iron oxide.  
Coke contains carbon.

(a) Quarrying iron ore will have an impact on everything near to the quarry.

(i) Describe **one** positive impact and **one** negative impact of quarrying iron ore.

positive impact .....

.....

negative impact .....

.....

(2)

(ii) Draw a ring around the correct answer to complete the sentence.

Ores contain enough metal to make extraction of the metal

- carbon neutral.
- economical.
- reversible.

(1)

(b) Many chemical reactions take place in a blast furnace.  
Use the flow diagram to help you to answer this question.

Suggest how the blast furnace is heated.

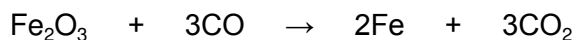
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(1)



(c) A chemical reaction for the extraction of iron is:



(i) Complete the word equation for this chemical reaction.

..... + carbon monoxide → iron + .....

(2)

(ii) Draw a ring around the correct answer to complete the sentence.

Iron is extracted from its ore by

- decomposition.
- oxidation.
- reduction.

(1)

(d) Cast iron contains about 4% carbon.  
Cast iron is converted into low-carbon steels.

(i) Low-carbon steel is produced by blowing oxygen into molten cast iron.

Suggest how oxygen removes most of the carbon.

.....  
.....  
.....  
.....

(2)

(ii) Draw a ring around the correct answer to complete the sentence.

Metals, such as nickel, are added to low-carbon steels to make the steel

- corrode easily.
- easy to shape.
- much harder.

(1)

- (e) Recycling steel uses less energy than producing steel from iron ore.

Tick (✓) **one** advantage and Tick (✓) **one** disadvantage of recycling steel.

<b>Statement</b>	<b>Advantage Tick (✓)</b>	<b>Disadvantage Tick (✓)</b>
Iron is the second most common metal in the Earth's crust.		
Less carbon dioxide is produced.		
More iron ore needs to be mined.		
There are different types of steel which must be sorted.		

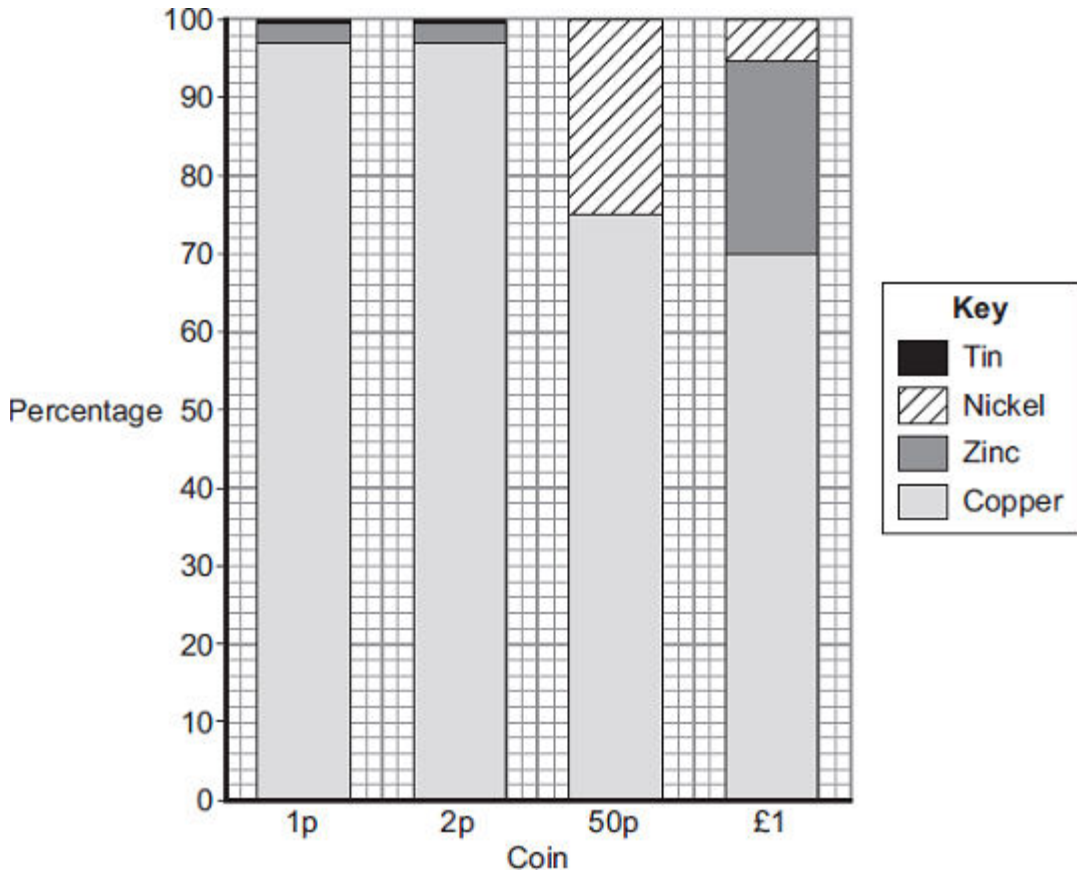
(2)  
(Total 12 marks)

14

This is the headline from a newspaper:

**'Why is a 2p coin worth 3.3p?'**

(a) The bar chart shows the percentage of metals in UK coins in 1991.



Use the bar chart to answer these questions.

(i) Which metal is in all of these coins?

.....

(1)

(ii) Which coin does **not** contain zinc?

.....

(1)

(iii) What is the percentage of nickel in a 50 p coin?

Percentage = ..... %

(1)

- (iv) Draw a ring around the correct metal to complete the sentence.

Pure copper is too soft to be used for 1 p and 2 p coins.

Copper is mixed with zinc and

iron

nickel

tin

for 1 p and 2 p coins.

(1)

- (b) The value of the metal in 2 p coins, made in 1991, is now 3.3 p.

Suggest why a 2 p coin made in 1991 is worth 3.3 p.

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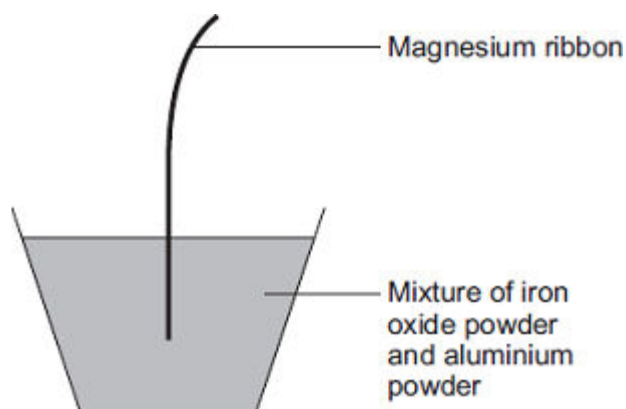
.....

(1)

(Total 5 marks)

15

The diagram shows one way of producing iron.



Iron oxide reacts with aluminium to produce iron.

The symbol equation for the reaction is:



- (a) (i) Complete the word equation for this reaction.

iron oxide + aluminium  $\longrightarrow$  iron + .....

(1)

(ii) The magnesium ribbon is lit to start the reaction.

Why does the burning magnesium ribbon start the reaction?

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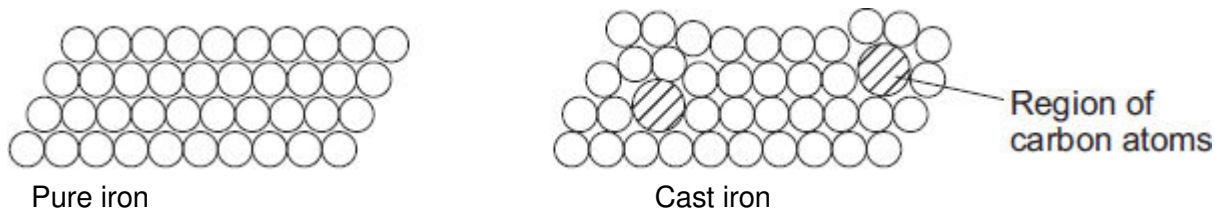
(1)

(b) In industry, iron is produced in the blast furnace when iron oxide is heated with carbon.

The iron from the blast furnace is called cast iron.

Cast iron contains carbon.

The diagrams show the structure of pure iron and cast iron.



Use the diagrams to help you answer the questions.

(i) Draw a ring around the correct answer to complete the sentence.

Pure iron is an element because pure iron

- contains only one sort of atom.
- is magnetic.
- is a metal.

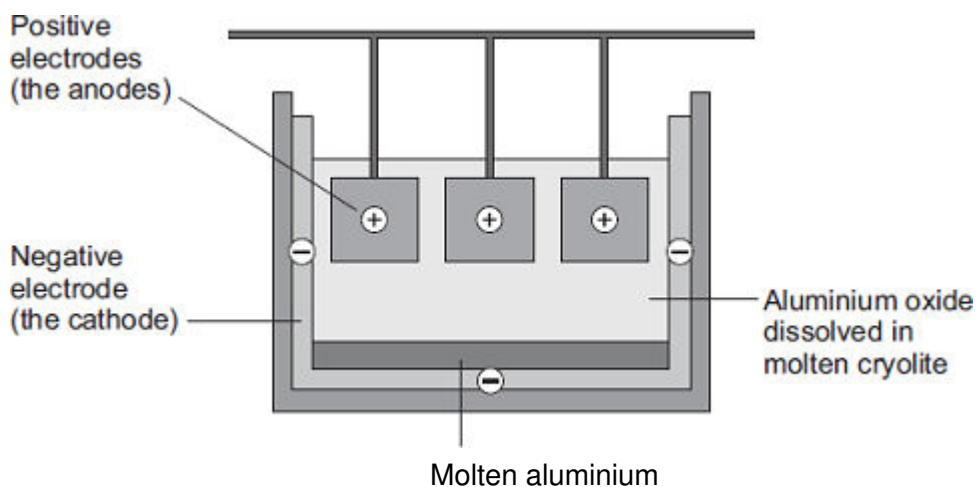
(1)

(ii) Suggest why cast iron is harder than pure iron.

.....  
.....  
.....  
.....  
.....

(2)

(c) Aluminium is extracted by electrolysis using the ionic compound aluminium oxide.



(i) Aluminium **cannot** be extracted by heating aluminium oxide with carbon.

Suggest why.

.....  
 .....

(1)

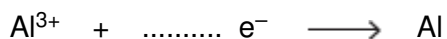
(ii) Why is aluminium oxide dissolved in molten cryolite?

.....  
 .....

(1)

(iii) Aluminium metal is produced at the negative electrode (cathode).

Complete the half equation for the process.



(1)

(iv) Use the half equation to state why  $\text{Al}^{3+}$  ions are reduced.

.....  
 .....

(1)

(v) Explain why the positive electrodes (anodes) burn away.

Use your knowledge of the products of electrolysis to help you.

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(4)  
(Total 13 marks)

16

A student was investigating the reaction of lithium and water.

She added a few drops of universal indicator to water in a trough and added a piece of lithium.



The word equation for the reaction is:



(a) (i) The lithium floated on the water.

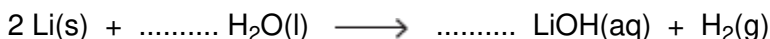
State **two** other observations that the student would **see** during the reaction.

1 .....

2 .....

(2)

(ii) Balance the symbol equation for the reaction of lithium and water.



(2)

(iii) Describe a simple test and the result that would show the gas was hydrogen.

.....  
.....

(1)

(iv) All Group 1 metals have similar reactions with water.

State why, in terms of electronic structure.

.....  
.....

(1)

(b) Lithium and other Group 1 metals have different properties from the transition metals.

Tick (✓) **two** properties that are properties of Group 1 metals.

They react with oxygen.

They form coloured compounds.

They are strong and hard.

They have low melting points.

(2)

(c) The electronic structure of a potassium atom is 2, 8, 8, 1

(i) Draw a diagram to show the electronic structure of a potassium ion.

Show the charge on the potassium ion.

(2)



(ii) Potassium is more reactive than sodium.

Explain why, in terms of electronic structure.

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**(3)**  
**(Total 13 marks)**

17

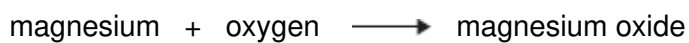
Magnesium burns in oxygen.



By Kingsway School [CC BY 2.0],  
via Flickr

- (a) Use the Chemistry Data Sheet to help you to answer this question.

The word equation for magnesium burning is:

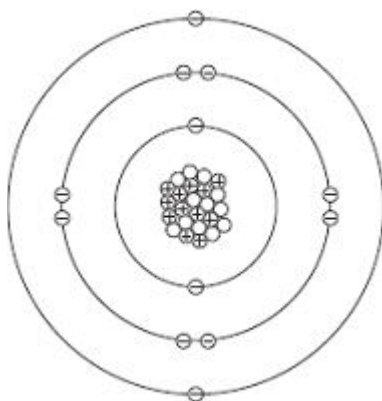


Draw **one** line from each substance to its correct description.

Substance	Description
magnesium	compound
magnesium oxide	metal
oxygen	mixture
	non-metal

(3)

- (b) The diagram represents a magnesium atom.



Complete the table to show the name of each particle and the charge of each particle in the magnesium atom.

Name of particle	Charge
proton	+1
neutron	.....
.....	-1

(2)

- (c) Use the Chemistry Data Sheet to help you to answer these questions.

Draw a ring around the correct answer to complete each sentence.

- (i) In a magnesium atom, the protons and neutrons are in the

core.
nucleus.
shell.

(1)

- (ii) The number of protons in a magnesium atom is the

atomic number
mass number.
group number.

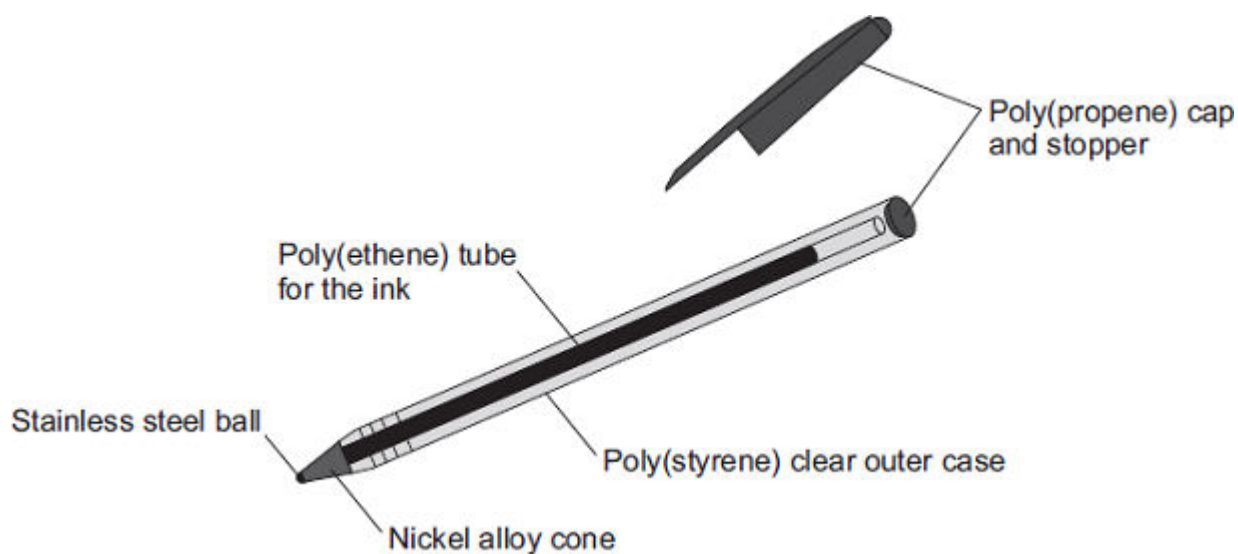
(1)

- (iii) The sum of the protons and neutrons in a magnesium atom is the

atomic number.
mass number.
group number.

(1)

**(Total 8 marks)**



(a) Polymers are used to make the ballpoint pen.

(i) Name the monomer used to make poly(ethene).

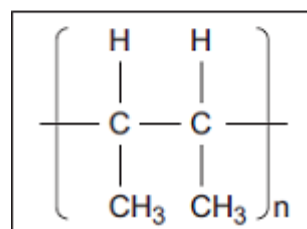
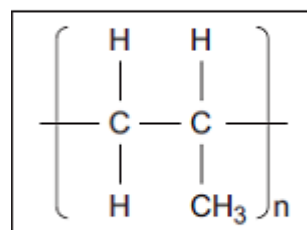
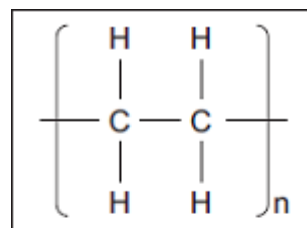
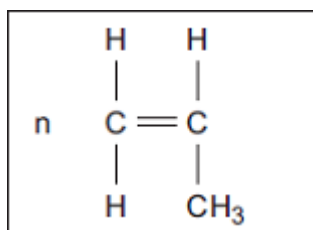
.....

(1)

(ii) Draw **one** line from the monomer propene to its polymer poly(propene).

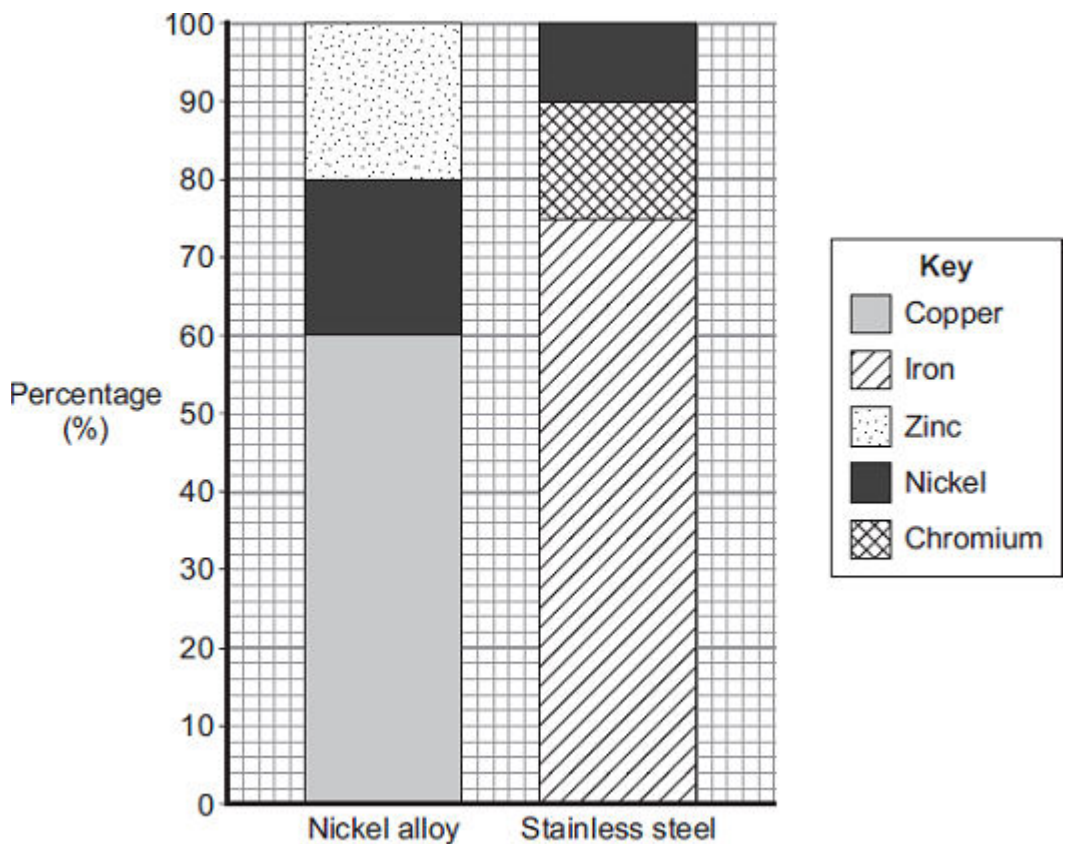
**Monomer**

**Polymer**



(1)

(b) Two alloys are used to make the ballpoint pen.



Use the bar chart to answer these questions.

(i) Which metal is in both of these alloys? ..... (1)

(ii) What is the percentage of iron in the stainless steel? ..... % (1)

(iii) The alloy stainless steel is used instead of pure iron for the ball of the pen.

Give **two** reasons why.

.....

.....

.....

.....

(2)

(c) Tick (✓) **one** advantage and tick (✓) **one** disadvantage of **recycling** this type of ballpoint pen.

	<b>Advantage Tick (✓)</b>	<b>Disadvantage Tick (✓)</b>
Can be refilled and reused		
Conserves resources of crude oil and ores		
High cost of separating materials		
Polymers and alloys are not expensive		

(2)  
(Total 8 marks)

**19** Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

(a) Copper is now extracted from ores containing a low percentage of copper compounds.

Suggest **two** reasons why.

.....

.....

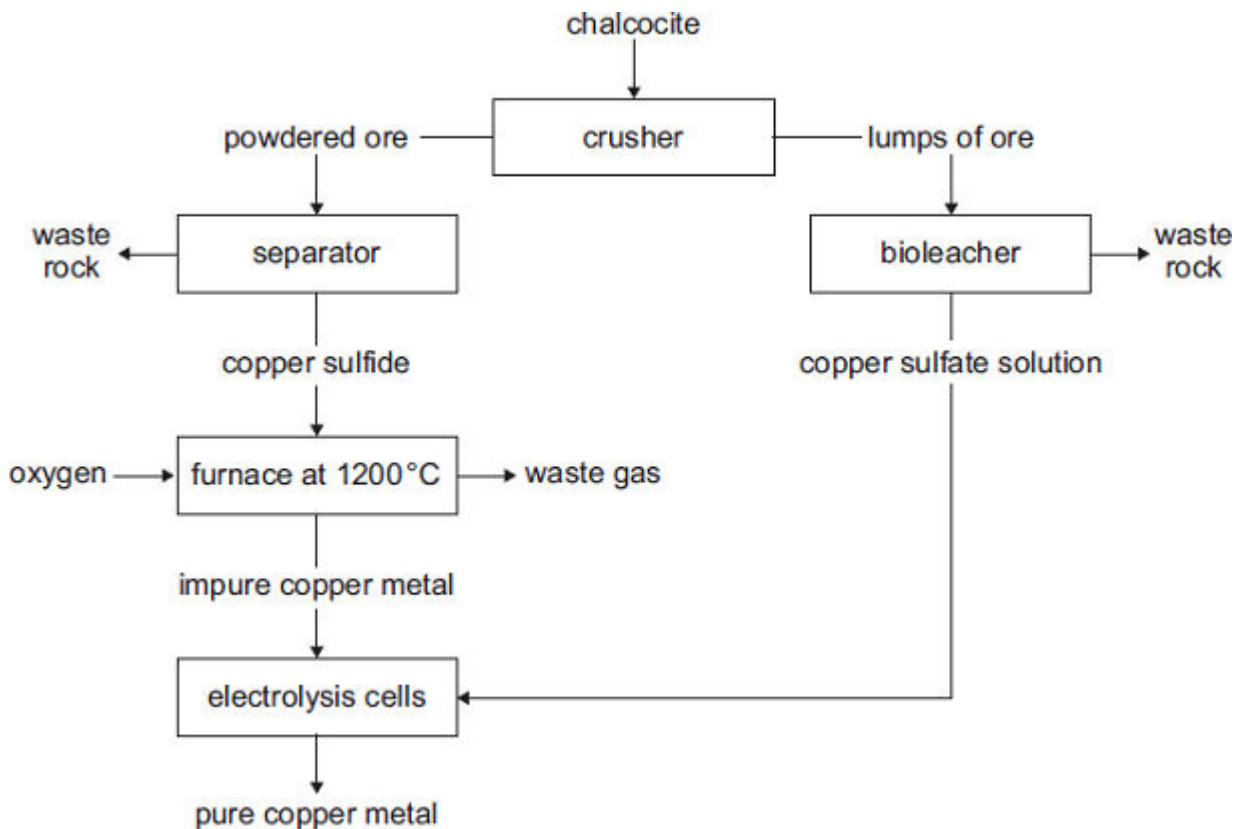
.....

.....

(2)

(b) Chalcocite, an ore of copper, contains copper sulfide.

The flow diagram shows how copper metal is extracted from chalcocite.



(i) Suggest **one** reason why it is difficult to dispose of the waste rock.

.....

.....

(1)

(ii) The reaction in the furnace could cause environmental pollution. Explain how.

.....

.....

.....

.....

(2)

(iii) The extraction of pure copper is expensive. Give **one** reason why.

.....

.....

(1)

(iv) Pure copper is produced by electrolysis of copper sulfate solution.

Which electrode do the copper ions move towards?  
Give a reason for your answer.

.....  
.....  
.....  
.....

(2)

(v) Large areas of land are contaminated with copper compounds.  
Phytomining can be used to remove these copper compounds from the land.

What is used in phytomining to remove copper compounds from the land?

.....  
.....

(1)

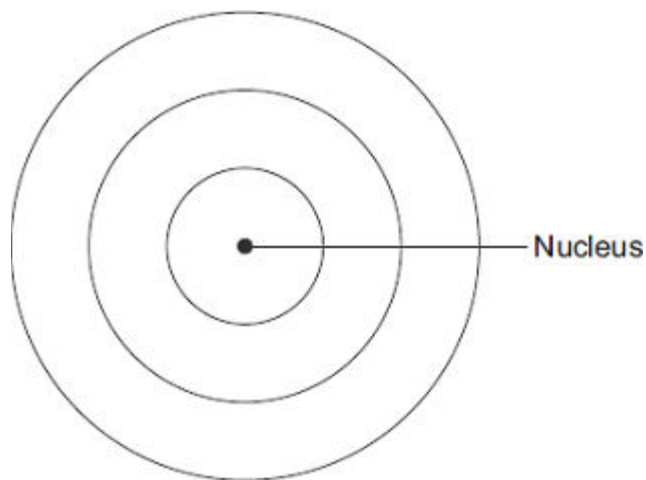
(Total 9 marks)

20

Aluminium has many uses.

(a) An aluminium atom has 13 electrons.

(i) Draw the electronic structure of an aluminium atom.



(1)

(ii) Name the **two** sub-atomic particles in the nucleus of an aluminium atom.

..... and .....

(1)



(iii) Why is there no overall electrical charge on an aluminium atom?

.....  
 .....

(1)

(b) Rail tracks are made from steel.

Molten iron is used to weld rail tracks.

The reaction of aluminium with iron oxide is used to produce molten iron.

(i) Balance the chemical equation for the reaction.



(1)

(ii) Why does aluminium react with iron oxide?

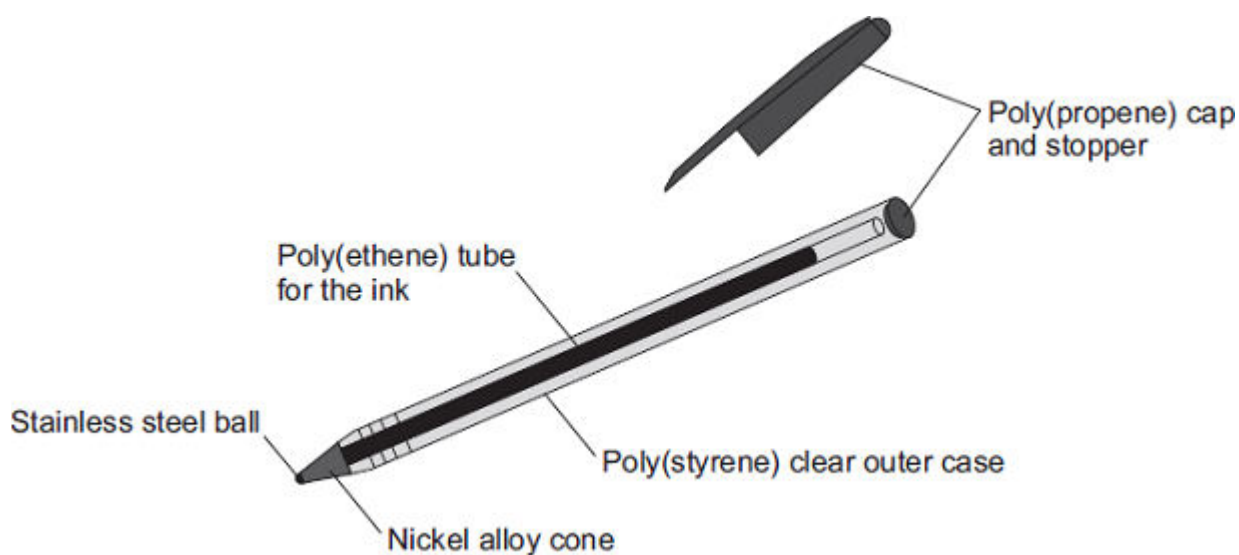
.....  
 .....

(1)

(Total 5 marks)

21

The diagram shows a ballpoint pen.



(a) Give **one** advantage and **one** disadvantage of recycling the materials from this type of ballpoint pen.

.....  
 .....

(2)

(b) Alloys are used to make the ballpoint pen.

Give **two** reasons why alloys are used in the ballpoint pen.

.....

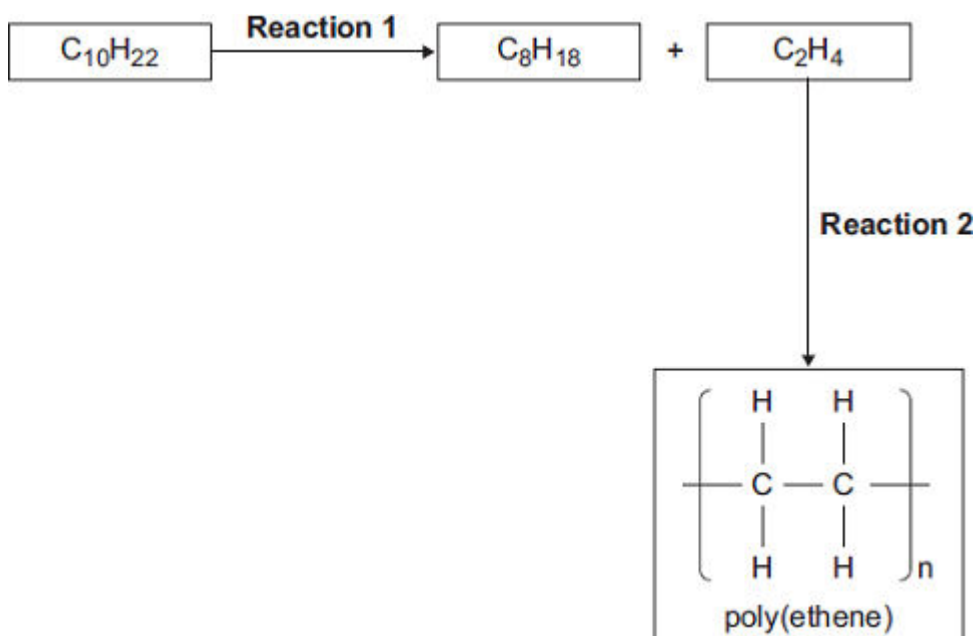
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(2)

(c) Decane ( $C_{10}H_{22}$ ) can be used to produce poly(ethene).



(i) Describe the conditions needed for **Reaction 1**.

.....

.....

.....

.....

(2)

(ii) Describe, in terms of molecules, how poly(ethene) is produced in **Reaction 2**.

.....

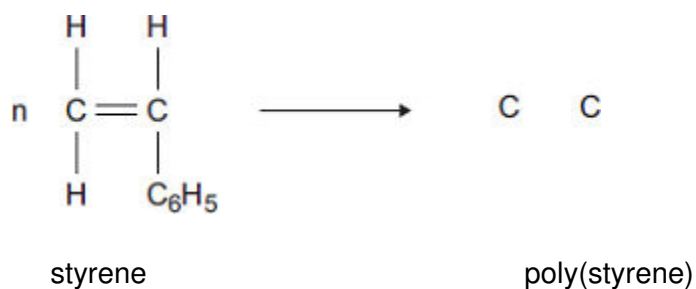
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(2)

- (d) Complete the displayed structure of the product in the equation.



(2)  
(Total 10 marks)

22

This question is about potassium.

- (a) Humphrey Davy was a professor of chemistry.

In 1807 Davy did an electrolysis experiment to produce potassium.

- (i) Davy first tried to electrolyse a solid potassium salt to produce potassium.

Explain why this electrolysis did **not** work.

.....

.....

.....

.....

(2)

- (ii) Humphrey Davy was the first person to produce potassium.

Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists.

Suggest why.

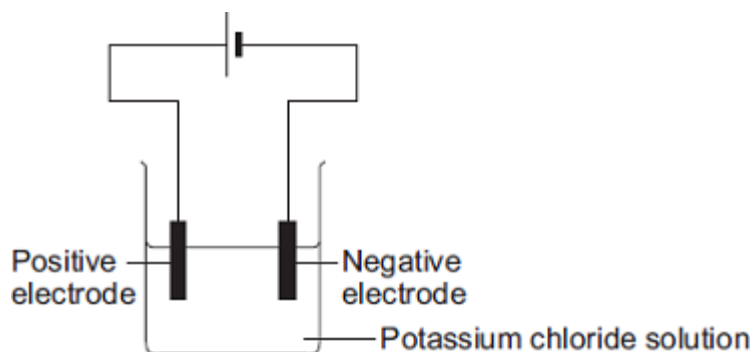
.....

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(1)

- (b) A student dissolved some potassium chloride in water. The student tried to electrolyse the potassium chloride solution to produce potassium.

The apparatus the student used is shown in the diagram.



The student expected to see potassium metal at the negative electrode, but instead saw bubbles of a gas.

- Name the gas produced at the negative electrode.
- Explain why this gas was produced at the negative electrode **and** why potassium was not produced.

The reactivity series of metals on the Chemistry Data Sheet may help you to answer this question.

.....

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.....

.....

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.....

.....

**(3)**

- (c) The student tried to electrolyse molten potassium chloride to produce potassium.

- (i) Potassium metal was produced at the negative electrode.

Describe how potassium atoms are formed from potassium ions.

.....

.....

.....

.....

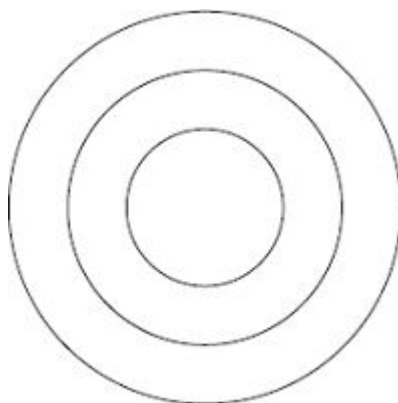
**(2)**

- (ii) Complete and balance the equation for the reaction at the positive electrode.



(1)

- (iii) Complete the diagram to show the electronic structure of a chloride ion ( $\text{Cl}^-$ ).



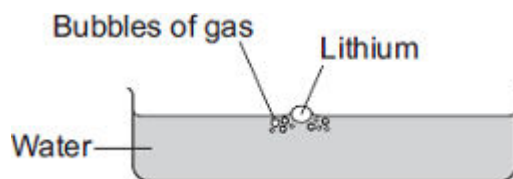
(1)

(Total 10 marks)

**23**

Lithium is in Group 1 of the periodic table.

Lithium reacts with water to produce a gas and an alkaline solution.



- (a) (i) Name the gas produced.

.....

(1)

- (ii) Which ion causes the solution to be alkaline?

.....

(1)

- (b) Potassium is also in Group 1 of the periodic table.  
Potassium reacts with water in a similar way to lithium.

Write down **two** differences you would see between the reactions of potassium and lithium with water.

1 .....

.....

2 .....

.....

(2)  
(Total 4 marks)

24

Cans for food and drinks are made from steel or aluminium.  
The main metal in steel is iron.

- (a) Reacting iron oxide with carbon produces iron.

Draw a ring around the correct answer to complete the sentence.

The reaction to produce iron from iron oxide is

decomposition.

oxidation.

reduction.

(1)

- (b) Aluminium cannot be produced by reacting aluminium oxide with carbon.

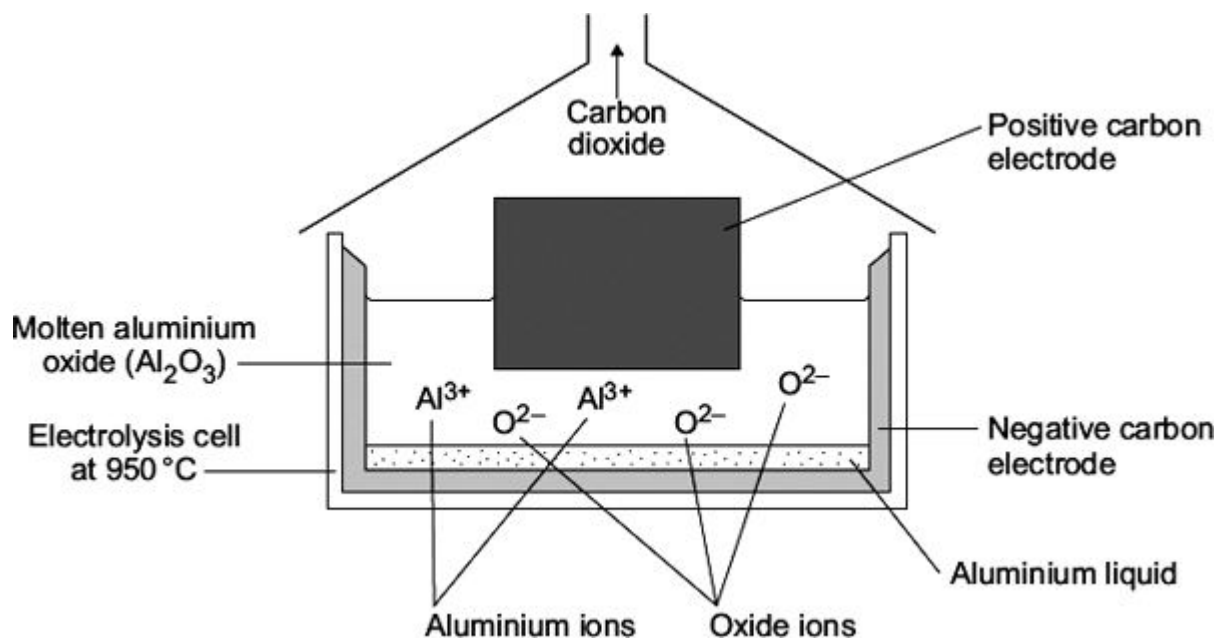
Why does aluminium oxide **not** react with carbon?

Tick (✓) the correct answer.

Answer	Tick (✓)
aluminium is less reactive than carbon	
carbon is less reactive than aluminium	
oxygen is more reactive than carbon	

(1)

(c) Aluminium can be produced by electrolysis.



Why do the aluminium ions collect at the negative electrode?

.....

.....

.....

.....

(2)

(d) Some statements about aluminium are given below.

Tick (✓) **two** statements that are correct reasons why aluminium is used to make cans.

Statement	Tick (✓)
aluminium conducts electricity	
aluminium is not a transition metal	
aluminium has a low density	
aluminium is resistant to corrosion	

(2)

- (e) Recycling aluminium cans uses less fossil fuels than producing aluminium from its ore.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of recycling aluminium to make aluminium cans.

<b>Statement</b>	<b>Advantage Tick (✓)</b>	<b>Disadvantage Tick (✓)</b>
aluminium is the most common metal in the Earth's crust		
less carbon dioxide is produced		
more aluminium ore needs to be mined		
used aluminium cans have to be collected and transported		

(2)  
(Total 8 marks)



**25**

Cans for food and drinks are made from steel or aluminium.  
The main metal in steel is iron.



By Sun Ladder (Own work) [CC-BY-SA-3.0 or GFDL],  
via Wikimedia Commons

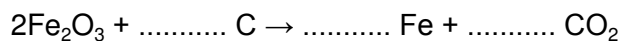
(a) Iron is extracted by heating a mixture of iron oxide and carbon in a blast furnace.

(i) Name this type of reaction.

.....

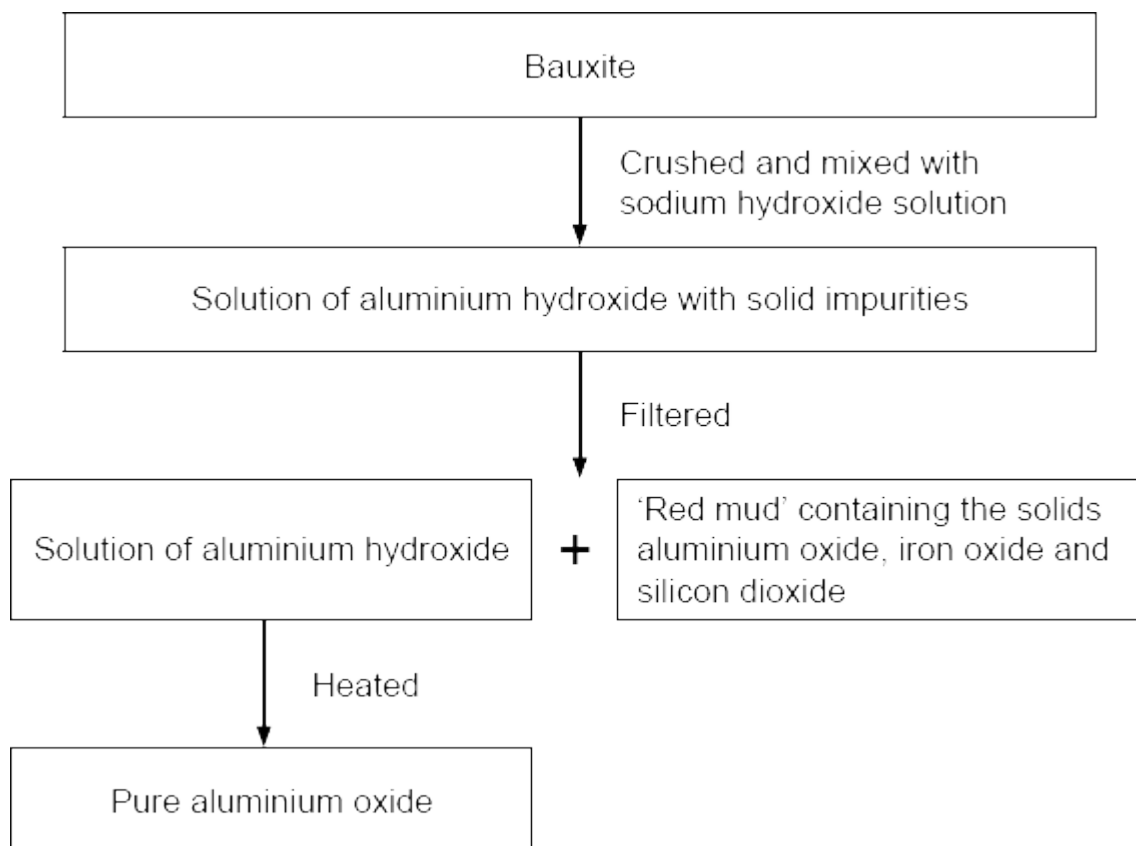
**(1)**

(ii) Balance the symbol equation for this reaction.



**(1)**

- (b) Aluminium ore, bauxite, contains aluminium oxide, iron oxide and silicon dioxide. Aluminium is extracted by electrolysis of aluminium oxide.



The 'red mud' which is dumped in very large ponds contains:

Name of solid	Percentage (%)
Aluminium oxide	10
Iron oxide	65
Silicon dioxide	25

- (i) 100 tonnes of bauxite produced 50 tonnes of pure aluminium oxide and 50 tonnes of 'red mud'.

What percentage of aluminium oxide did the bauxite contain?

.....

Answer = ..... %

(1)

- (ii) Apart from the solids shown in the table, name **one** other substance that would be in the 'red mud'.

.....

(1)

(iii) The purification of the aluminium oxide is usually done near to the bauxite quarries.

Suggest **one** reason why.

.....

(1)

(c) Aluminium is used to make many things including cans.

During one year in the USA:

- 100 billion aluminium cans were sold
- 55 billion aluminium cans were recycled.

Give **one** environmental impact of recycling aluminium cans and **one** ethical or social impact of recycling aluminium cans.

Environmental .....

.....

Ethical or social .....

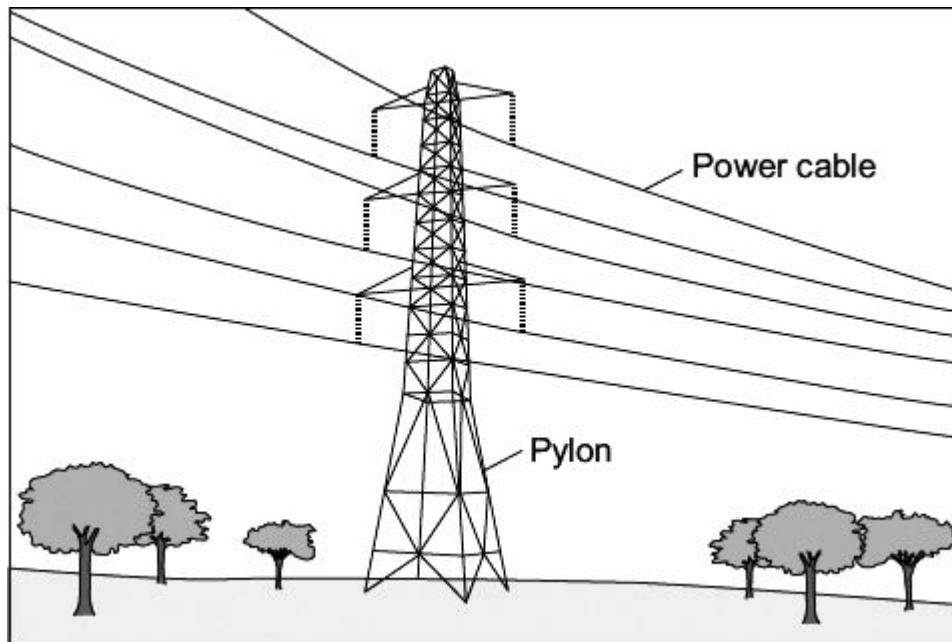
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(2)

(Total 7 marks)

26

Metals are used in the manufacture of pylons and overhead power cables.



(a) Suggest **one** reason why iron (steel) is used to make pylons.

.....  
 .....

(1)

(b) The table shows some of the properties of two metals.

Metal	Density in g per cm <sup>3</sup>	Melting point in °C	Percentage(%) relative electrical conductivity	Percentage(%) abundance in Earth's crust
copper	8.92	1083	100	0.007
aluminium	2.70	660	60	8.1

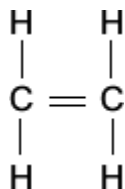
Use the information in the table to suggest why aluminium and **not** copper is used to conduct electricity in overhead power cables.

.....  
 .....

(2)

- (c) A polymer can be used to cover and insulate power cables.

The polymer is made from the alkene:



Draw a ring around the correct answer to complete each of the sentences.

- (i) The chemical formula of this alkene is

CH

CH<sub>4</sub>

C<sub>2</sub>H<sub>4</sub>

(1)

- (ii) The two lines between the carbon atoms are called a

double bond.

nucleus.

single bond.

(1)

- (iii) The name of the polymer formed when many of these alkene molecules join together

poly(ethene).

is poly(ethenol).

poly(propene).

(1)

(Total 6 marks)

27

Read the information.

Alumina is a white solid. In 1800, scientists thought that alumina contained an undiscovered metal. We now call this metal aluminium. At that time, scientists could not extract the aluminium from alumina.

In 1825, Christian Oersted, a Danish scientist, did experiments with alumina.

**Step 1** He reacted a mixture of hot alumina and carbon with chlorine to form aluminium chloride. The reaction is very endothermic.

**Step 2** The aluminium chloride was reacted with potassium. He was left with potassium chloride and tiny particles of aluminium metal.

Other scientists were **not** able to obtain the same results using his experiment and his work was not accepted at that time.

In 1827, Friedrich Wöhler, a German chemist, made some changes to Oersted's experiment. He obtained a lump of aluminium. He tested the aluminium and recorded its properties.

- (a) Suggest why scientists in 1800 could not extract aluminium from alumina.

.....  
 .....

(1)

- (b) Oersted's experiment in 1825 was **not** thought to be reliable.

Explain why

.....  
 .....

(1)

- (c) Why must the reaction in **Step 1** be heated to make it work?

.....  
 .....

(1)

- (d) Complete the word equation for the reaction in **Step 2**.

aluminium  
 chloride + potassium → ..... + .....

(1)

(e) Suggest how Wöhler was able to prove that he had made a new metal.

.....

.....

.....

.....

**(2)**  
**(Total 6 marks)**

**28**

Iron is extracted from its ore.

(a) Iron ore is quarried.



Photograph supplied by Stockbyte/Thinkstock

Quarrying iron ore has impacts that cause environmental problems.

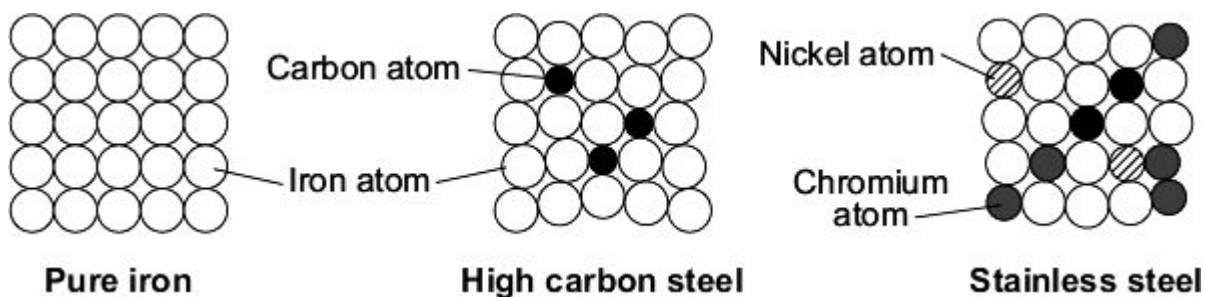
Tick (✓) **two** impacts of quarrying that cause environmental problems.

Impact of quarrying	Tick (✓)
puts off tourists	
causes dust pollution	
increases jobs	
increases traffic	

**(2)**



(b) The diagrams represent the atoms in iron and the atoms in two alloys of iron.



Use the diagrams to help you to answer these questions.

(i) Complete the sentence.

Pure iron does **not** have many uses because .....

.....

(1)

(ii) Stainless steel is more expensive than pure iron.

Suggest why.

.....

.....

(1)

(c) Draw a ring around the correct answer to complete each sentence.

(i) Pure iron is

- a compound.
- an element.
- a mixture.

(1)

(ii) High carbon steel is used for a drill bit because it is

- brittle.
- easily bent.
- hard.

(1)

(iii) Stainless steel is used to make cutlery because it

contains three different atoms.  
 melts at a very high temperature.  
 is resistant to corrosion.

(1)

**(Total 7 marks)****29**

Steels are used to make cars, bridges and knives.  
 The main element in steel is iron.

(a) Iron is extracted from an *ore* that contains about 60% iron oxide,  $\text{Fe}_2\text{O}_3$

(i) What is the meaning of *ore*?

.....  
 .....

(1)

(ii) In a blast furnace, iron oxide reacts with carbon monoxide to produce iron.  
 The word equation for this reaction is:

iron oxide + carbon monoxide  $\rightarrow$  iron + carbon dioxide

Complete and balance the chemical equation for this reaction.

$\text{Fe}_2\text{O}_3$  + ..... CO  $\rightarrow$  ..... + .....

(2)

(iii) Name the type of reaction that produces a metal from its metal oxide.

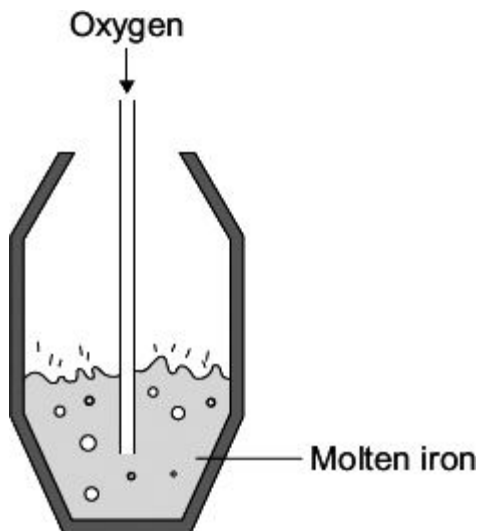
.....

(1)

(b) Steels are produced from molten iron in two stages:

**Stage 1** blowing oxygen into molten iron from the blast furnace.

**Stage 2** adding other metals to make different steels.



(i) In **Stage 1**, suggest how the oxygen removes most of the carbon from the molten iron.

.....

.....

.....

.....

(2)

(ii) **Stage 2** produces different steels.

Suggest why different steels are needed.

.....

.....

(1)

- (c) Old 5p and 10p coins in the UK were made from cupro-nickel. Cupro-nickel is 75% copper and 25% nickel.

New 5p and 10p coins in the UK are now made from nickel-plated steel and not from cupro-nickel.

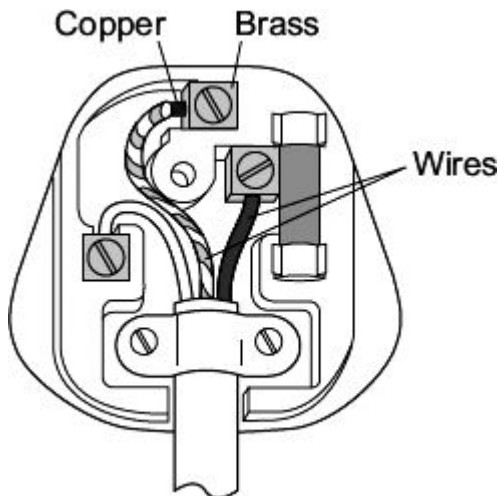
Explain why.

.....  
.....  
.....  
.....

(2)  
(Total 9 marks)

30

The diagram shows an electric plug.



- (a) (i) Draw a ring around the correct answer to complete the sentence.

Copper is used for the wires because it

- conducts electricity.
- conducts heat.
- is shiny.

(1)

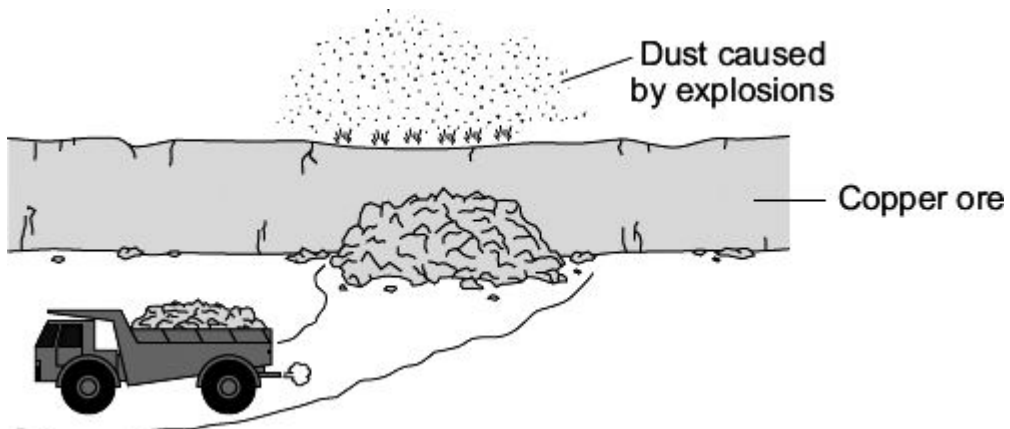
(ii) Brass is an *alloy* of copper and zinc.

What is an *alloy*?

.....  
.....

(1)

(b) Open-cast mines are used to obtain copper ore.



Suggest **two** reasons why people would **not** like to live near an open-cast mine.

1 .....

.....

2 .....

.....

(2)  
(Total 4 marks)

**31**

The flow diagram shows the main stages used to extract a metal from its ore.

mining the ore → purifying the ore → extracting the metal

The table shows some information about three metals.

<b>Metal</b>	<b>Metal ore</b>	<b>Purified ore</b>	<b>% of metal in the ore</b>	<b>% of metal in the Earth's crust</b>
aluminium	bauxite	aluminium oxide, $\text{Al}_2\text{O}_3$	28.0	8.0
copper	chalcocite	copper sulfide, $\text{Cu}_2\text{S}$	0.5	0.001
iron	haematite	iron oxide, $\text{Fe}_2\text{O}_3$	29.0	5.0

(a) Use the information in the table and your knowledge and understanding to help you to answer the questions.

(i) Suggest why purifying the copper ore produces large quantities of waste.

.....

.....

.....

**(1)**

(ii) Suggest why the annual world production of iron is forty times greater than that of aluminium.

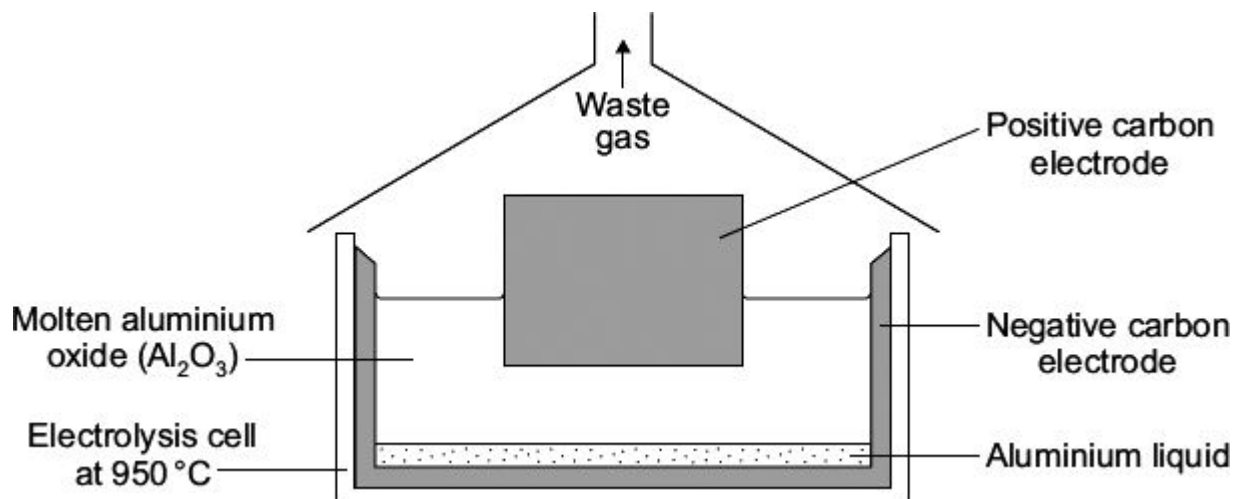
.....

.....

.....

**(1)**

- (b) Aluminium is used for drinks cans.  
Aluminium is extracted from its purified ore by electrolysis.



- (i) Suggest why the aluminium produced in the electrolysis cell is a liquid.

.....  
 .....

(1)

- (ii) In this electrolysis, aluminium and oxygen gas are produced from the aluminium oxide.

Use the information in the diagram to suggest why most of the waste gas is carbon dioxide and not oxygen.

.....  
 .....

(2)

(iii) Aluminium is the most abundant metal in the Earth's crust.

Suggest **two** reasons why we should recycle aluminium drinks cans.

1 .....

.....

2 .....

.....

(2)  
(Total 7 marks)

32

Titanium is used for replacement hip joints because it has a low density, is strong and does not corrode.

Titanium is extracted from titanium dioxide ( $\text{TiO}_2$ ) in three stages.

(a) **Stage 1**

Titanium dioxide is converted into titanium chloride ( $\text{TiCl}_4$ ) because the metal cannot be extracted from its oxide by *reduction* with carbon.

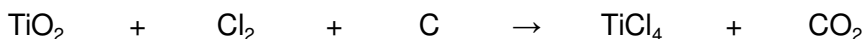
(i) What does *reduction* mean?

.....

.....

(1)

(ii) Balance the chemical equation for the conversion of titanium dioxide to titanium chloride.



(1)

(iii) Chemical equations are always balanced. Explain why.

.....

.....

.....

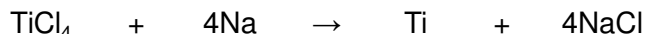
(1)



(b) **Stage 2**

Titanium is extracted from the titanium chloride by reacting it with sodium at 1000 °C in a reactor.

The only other substance in the reactor is argon gas.



(i) What does this tell you about the reactivity of sodium compared with titanium?

.....  
 .....

(1)

(ii) Suggest why the reactor contains argon and **not** air.

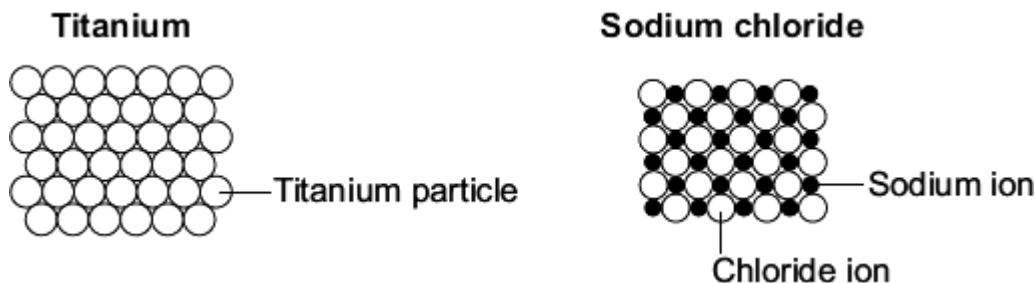
.....  
 .....

(1)

(c) **Stage 3**

After **Stage 2** the titanium is separated from the products by washing out the sodium chloride with water.

The diagrams show sections through the lattice of titanium metal and the lattice of sodium chloride.



How do the diagrams show that:

(i) titanium is an element

.....  
 .....

(1)

(ii) sodium chloride is a compound?

.....

.....

.....

.....

(2)  
(Total 8 marks)

**33**

An ore contains zinc carbonate ( $\text{ZnCO}_3$ ).

(a) Complete the table to show the number of atoms of each element in the formula of zinc carbonate.

Zinc has been done for you.

Element	Number of atoms in the formula $\text{ZnCO}_3$
Zinc, Zn	1
Carbon, C	
Oxygen, O	

(2)

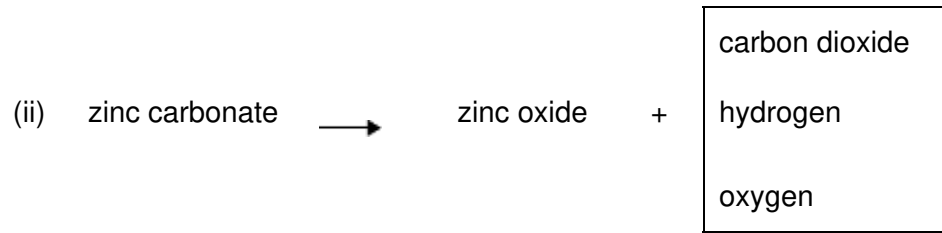
(b) Draw a ring around the correct answer to complete the sentence and the word equation.

(i) Zinc carbonate decomposes in a similar way to calcium carbonate

when

water is added.
cooled.
heated.

(1)



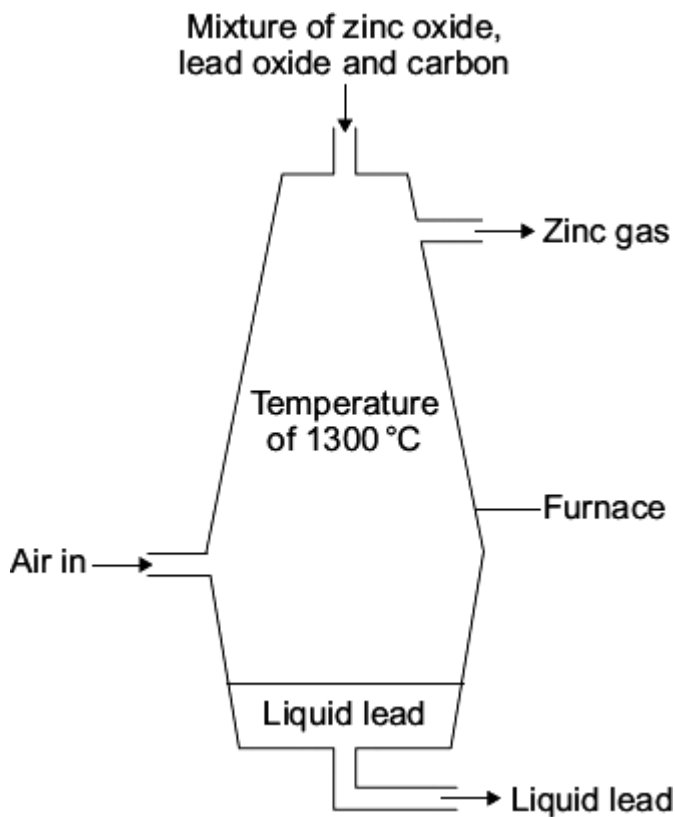
(1)

- (c) Another ore contains a mixture of zinc carbonate and lead carbonate.

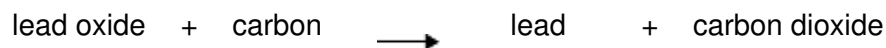
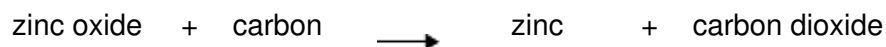
The metals zinc and lead are produced from this ore in two stages:

**Stage 1** decomposing the carbonates to produce a mixture of zinc oxide and lead oxide.

**Stage 2** mixing the oxides with carbon and heating in a furnace.



Some of the reactions in the furnace are:



Use the information given to help you to answer these questions.

- (i) Draw a ring around the correct answer to complete the sentence.

The reaction between carbon and oxygen that heats the

furnace is called

- |                |
|----------------|
| combustion.    |
| decomposition. |
| evaporation.   |

(ii) Tick (✓) **one** reason why carbon reacts with zinc oxide to produce zinc.

Reason	Tick (✓)
carbon is less reactive than zinc	
carbon is more reactive than zinc	
carbon is similar in reactivity to zinc	

(1)

(iii) In the furnace zinc is a gas but lead is a liquid.

Suggest why.

.....  
.....  
.....  
.....

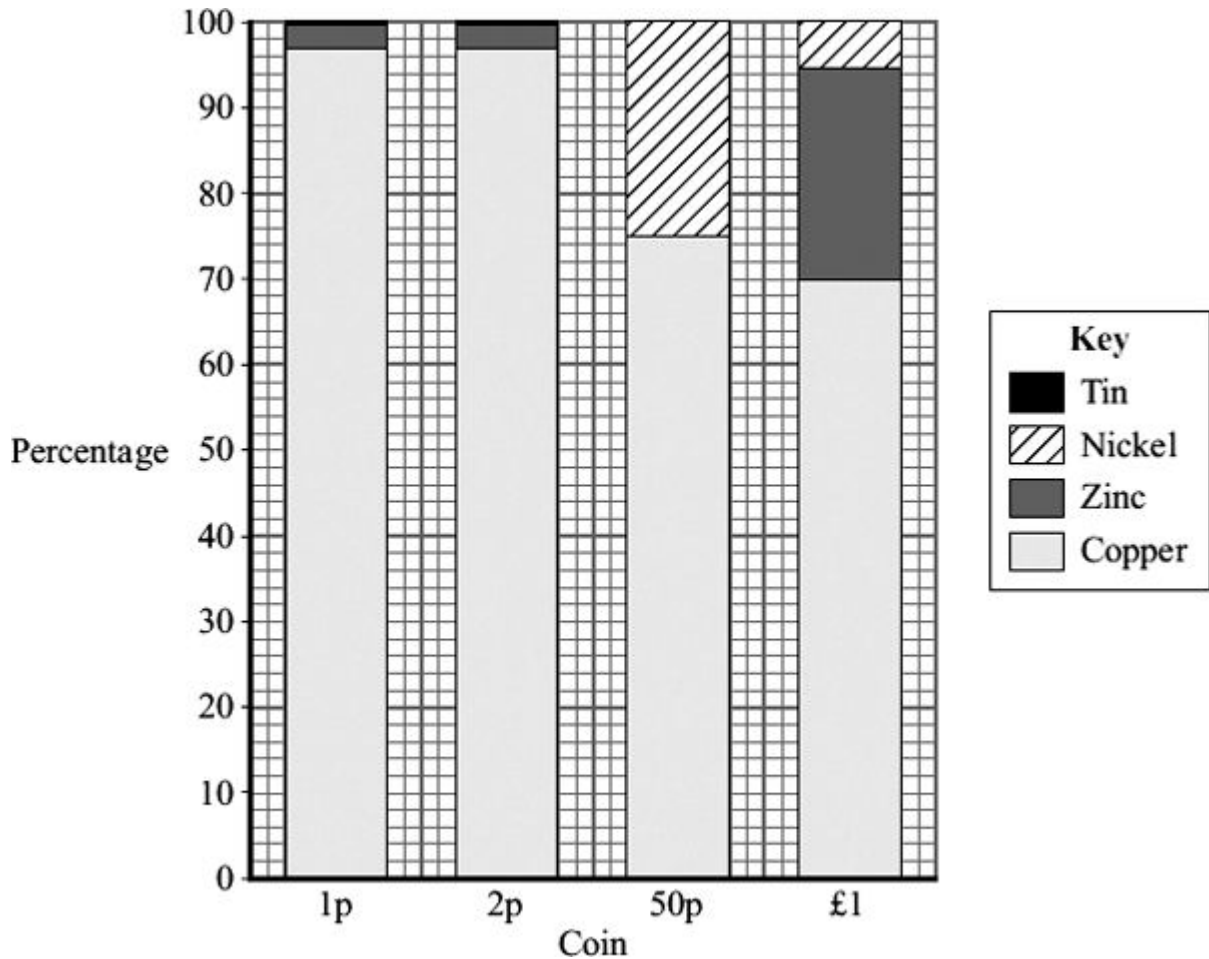
(2)  
(Total 8 marks)

34

This is the headline from a newspaper:

**‘Why is a 2p coin worth 3.3p?’**

(a) The bar chart shows the percentages of metals in UK coins in 1991.



Use the bar chart to answer these questions.

(i) Which metal is in all of these coins?

.....

(1)

(ii) Which coin does **not** contain zinc?

.....

(1)

(iii) What is the percentage of nickel in a 50p coin?

Percentage = ..... %

(1)

(iv) Draw a ring around the correct metal to complete the sentence.

Pure copper is too soft to be used for 1p and 2p coins.

Copper is mixed with zinc and 

nickel
tin
iron

 for 1p and 2p coins.

(1)

(b) The value of the metal in 2p coins which were made in 1991 is now 3.3p.

(i) Suggest why a 2p coin made in 1991 is worth 3.3p.

.....  
.....  
.....

(1)

(ii) Suggest why copper-plated steel is now used for 1p and 2p coins.

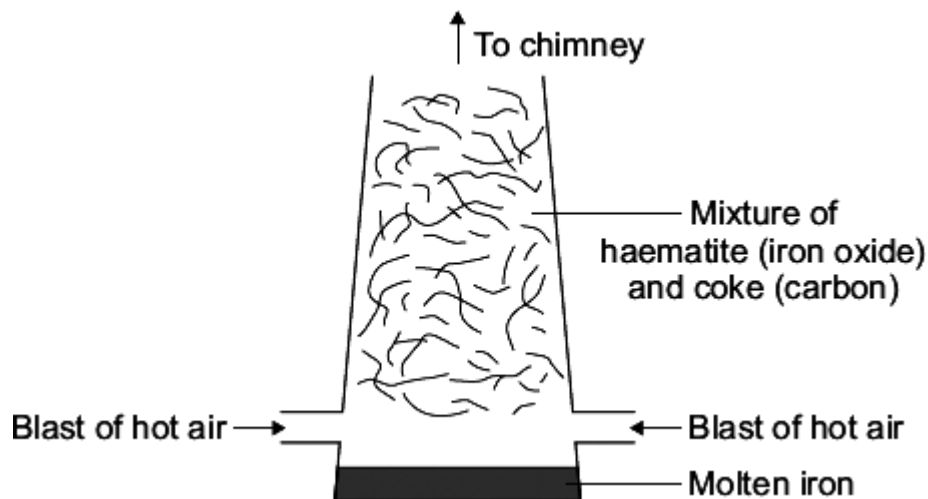
.....  
.....  
.....

(1)

**(Total 6 marks)**

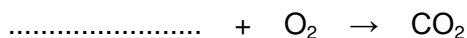
35

Iron is produced by reacting a mixture of haematite and coke in a blast furnace. Haematite is an ore of iron containing iron oxide ( $\text{Fe}_2\text{O}_3$ ). Coke is made from coal and is almost pure carbon.



- (a) (i) The coke burns in air. This reaction heats the furnace to above 1300 °C.

Complete the chemical equation for carbon reacting with oxygen to form carbon dioxide.



(1)

- (ii) Carbon monoxide is also formed in the furnace. Carbon monoxide reacts with iron oxide to produce iron and carbon dioxide.

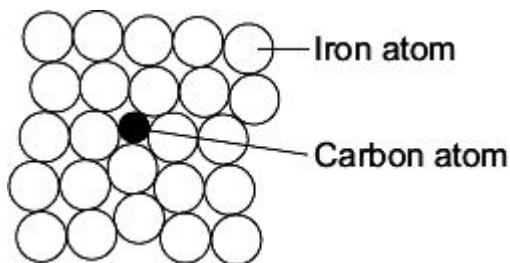


Complete and balance the chemical equation for the production of iron.



(2)

- (iii) Iron from a blast furnace is called cast iron and contains about 4% carbon.



Why is pure iron softer than cast iron?

.....  
 .....

(1)



- (b) Steel is made by reducing the percentage of carbon in cast iron and then adding different metals to form the type of steel required.

In the UK we use about 1.8 billion steel cans every year but only 30% of these are recycled. Recycling reduces waste. Producing steel from recycled cans requires only 25% of the energy needed to make steel from iron ore.

Give **three** environmental benefits of recycling a higher percentage of used steel cans.

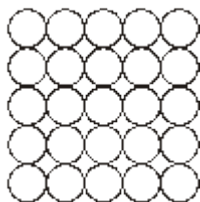
- 1 .....
- .....
- 2 .....
- .....
- 3 .....
- .....

(3)  
(Total 7 marks)

36

Iron is the main structural metal used in the world.

- (a) The diagram represents the particles in iron, Fe.



Draw a ring around the correct word in the box to complete the sentence.

Iron is described as an element because all the

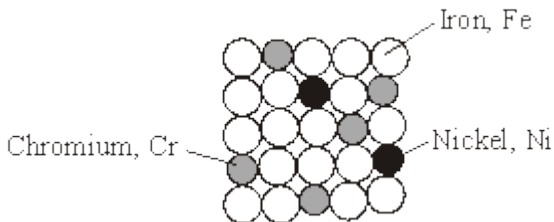
- atoms
- compounds
- metals

are the same.

(1)

(b) Stainless steel is mostly iron.

The diagram represents the particles in stainless steel.



Use the correct words from the box to complete the sentences about alloys.

**metal    mixture    molecule    polymer    smart    structure**

Stainless steel is an alloy because it is a ..... of iron, chromium and nickel.

An alloy is made up of more than one type of .....

Stainless steel alloys are harder than iron because the different sized atoms added change the .....

An alloy that can return to its original shape after being deformed is called a ..... alloy.

**(4)**

(c) In the UK, we use about 1.8 billion steel cans every year but only 25% are recycled. Used steel cans are worth about £100 per tonne.

Recycling saves raw materials and reduces waste that would end up in landfill. Producing steel by recycling used cans saves 75% of the energy that would be needed to produce steel from iron ore. This also reduces carbon dioxide emissions.

(i) Give **two** reasons, from the information above, to explain why recycling used steel cans is a good idea.

1 .....

.....

2 .....

.....

**(2)**

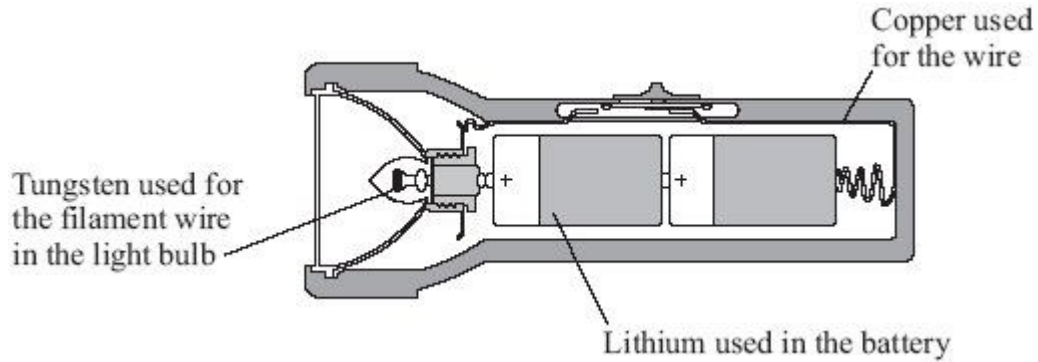
- (ii) Suggest how the local council could increase the percentage of used steel cans that are recycled.

.....  
.....

(1)  
(Total 8 marks)

37

The diagram shows a circuit that is used in a torch. Electrons flow through this circuit.

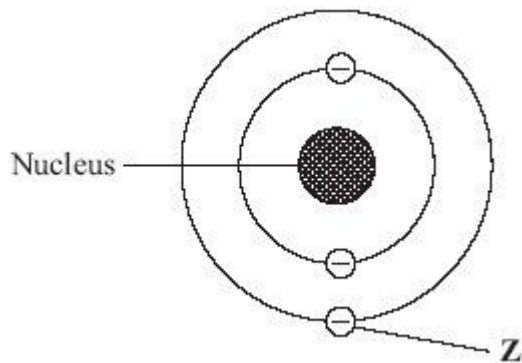


- (a) Why is copper used for the wire?

.....

(1)

- (b) The diagram shows the structure of an atom of lithium.



Name the particle labelled **Z**.

.....

(1)

- (c) The table shows some properties of the metals used in the electrical circuit.

Metal	Melting point in °C	Boiling point in °C	Reaction with oxygen
Copper	1083	2582	Reacts <b>slowly</b> to form a thin oxide layer on surface
Lithium	179	1317	Reacts <b>rapidly</b> to form oxide
Tungsten	3370	5930	Reacts <b>only</b> when very hot to form oxide

- (i) Use information from the table to suggest the order of reactivity for copper, lithium and tungsten.

**most reactive** .....

.....

**least reactive** .....

(2)

- (ii) The filament wire glows because it gets very hot.

Use information from the table to suggest **one** reason why tungsten is used for the filament wire in the light bulb.

.....

.....

(1)

- (d) The gas used in the light bulb is argon.

Draw a ring around the correct word in the box to complete the sentence.

Argon is used in the light bulb because it is

dense. solid. unreactive.
---------------------------------

(1)

(Total 6 marks)

38

(a) PEX is a material that is used as an alternative to copper for hot water pipes. PEX is made from poly(ethene).

(i) Describe how ethene forms poly(ethene).

.....  
.....  
.....  
.....

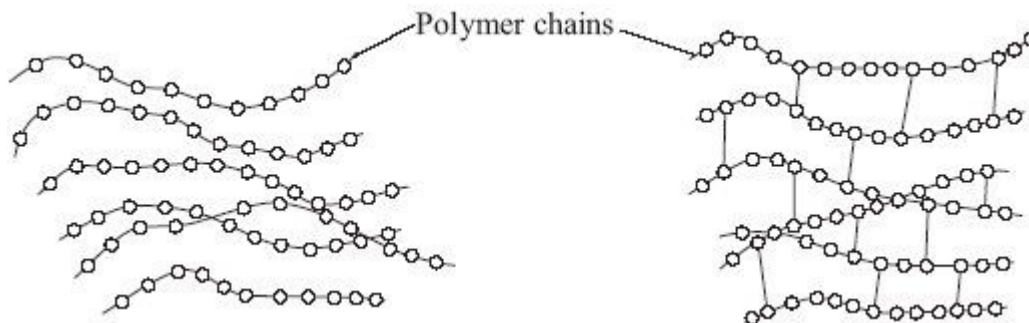
(2)

(ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

.....  
.....

(1)

(iii) The simplified structures of poly(ethene) and PEX are shown.



**Poly(ethene)**

**PEX**

Poly(ethene) is a thermoplastic that softens easily when heated.

Suggest and explain how the structure of PEX changes this property.

.....  
.....  
.....  
.....  
.....

(3)

- (b) Copper was considered to be the most suitable material to use for hot water pipes.  
PEX is now used as an alternative material for hot water pipes.

Copper is extracted from its ore by a series of processes.

- 1 The low-grade ore is powdered and concentrated.
- 2 Smelting is carried out in an oxygen flash furnace. This furnace is heated to 1100 °C using a hydrocarbon fuel. The copper ore is blown into the furnace with air, producing impure, molten copper.
- 3 Oxygen is blown into the impure, molten copper to remove any sulfur. The copper is cast into rectangular slabs.
- 4 The final purification of copper is done by electrolysis.

PEX is made from crude oil by a series of processes.

- 1 Fractional distillation
- 2 Cracking
- 3 Polymerisation
- 4 Conversion of poly(ethene) into PEX

Suggest the possible environmental advantages of using PEX instead of copper for hot water pipes.

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.....

.....

(4)  
(Total 10 marks)

39

Metals and their alloys have many uses.

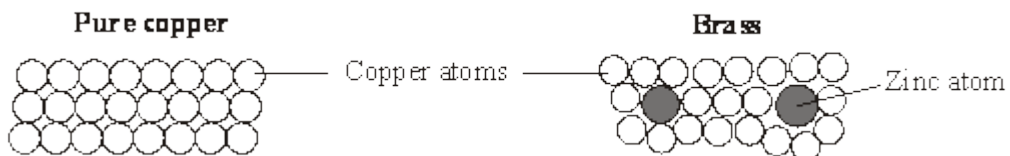
- (a) Dentists use a smart alloy to make braces that gently push teeth into the right position.

What is meant by a *smart alloy*?

.....  
.....

(1)

- (b) Pure copper is made up of layers of copper atoms. Brass is an *alloy* of copper and zinc.

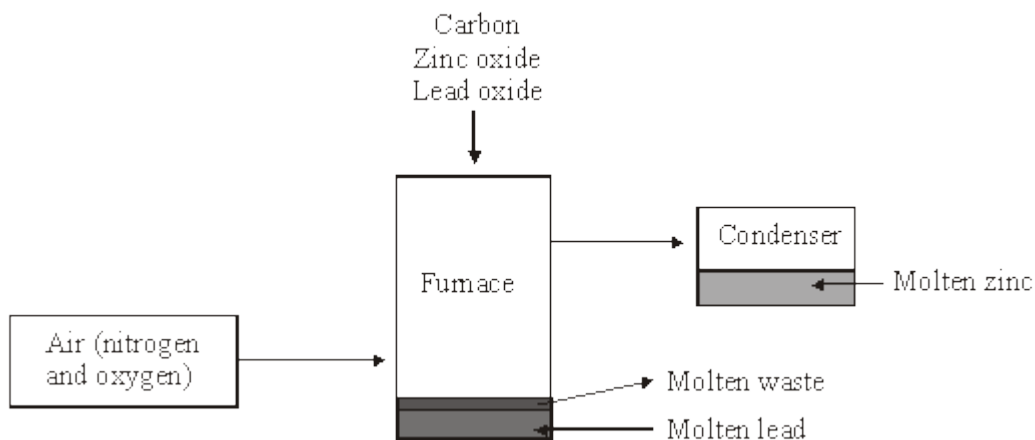


Why are the physical properties of brass different from the physical properties of pure copper?

.....  
.....  
.....  
.....

(2)

- (c) Nearly all zinc is obtained from ores that also contain lead. The metals zinc and lead can be extracted by reducing their oxides using carbon.



- (i) Choose **one** element from the box below to complete the sentence about the reduction of zinc oxide.

lead	nitrogen	oxygen
------	----------	--------

Zinc oxide is reduced by carbon, which takes away.....  
to leave zinc metal.

(1)

- (ii) The melting points and boiling points of lead and zinc are given in the table.

Metal	Lead	Zinc
Melting point in °C	328	420
Boiling point in °C	1740	907

The furnace operates at a temperature of 1200 °C.

Suggest how the lead metal and zinc metal are separated in the furnace.

.....

.....

.....

.....

(2)

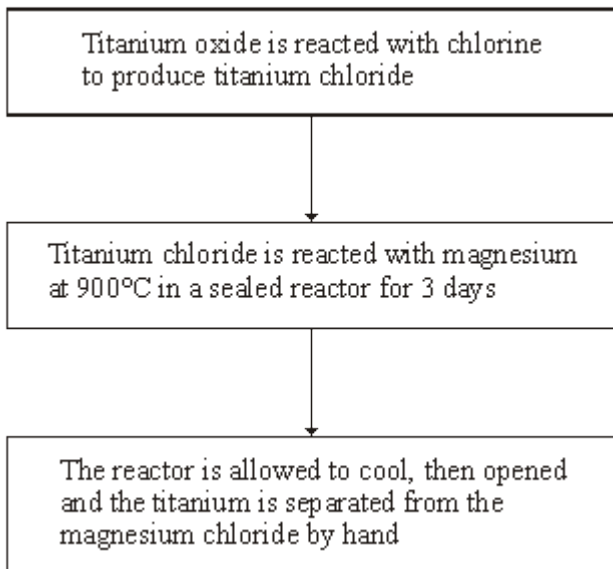
(Total 6 marks)



40

Titanium is used in aircraft, ships and hip replacement joints. Titanium is as strong as steel but 45% lighter, and is more resistant to acids and alkalis.

Most titanium is produced from its ore, rutile (titanium oxide), by a batch process that takes up to 17 days.



Titanium reactors produce about 1 tonne of the metal per day. Iron blast furnaces produce about 20 000 tonnes of the metal per hour.

(a) Give **one** property of titanium that makes it more useful than steel for hip replacement joints.

.....

(1)

(b) In the reactor magnesium is used to produce titanium. If carbon were used instead of magnesium, no titanium would be produced.

What does this tell you about the relative reactivities of carbon, magnesium and titanium?

.....  
.....  
.....  
.....

(2)

- (c) The use of titanium is limited because it is expensive.

Explain why titanium costs more than steel.

.....

.....

.....

.....

.....

.....

(3)  
(Total 6 marks)

41

Many everyday items are made from iron.

- (a) Haematite is an *ore* of iron. Haematite contains iron oxide,  $\text{Fe}_2\text{O}_3$ .

- (i) What is the meaning of the term *ore*?

.....

.....

(1)

- (ii) Iron can be produced by reacting iron oxide with carbon in a blast furnace.

What type of reaction produces the iron?

.....

.....

(1)

- (iii) The word equation for this reaction is:

iron oxide + carbon  $\rightarrow$  iron + carbon dioxide

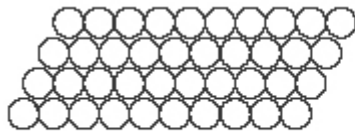
Complete and balance the symbol equation for this reaction.

..... $\text{Fe}_2\text{O}_3$  + .....C  $\rightarrow$  ..... + .....

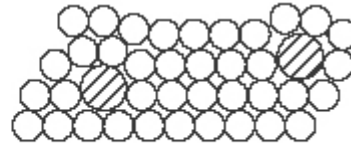
(2)

(b) Pure iron is relatively soft and not very strong.

The iron from the blast furnace is very hard and brittle. It contains about 4% carbon and is used as cast iron.



Pure iron



Cast iron

Explain the differences in the properties of pure iron and cast iron by referring to the diagrams.

.....

.....

.....

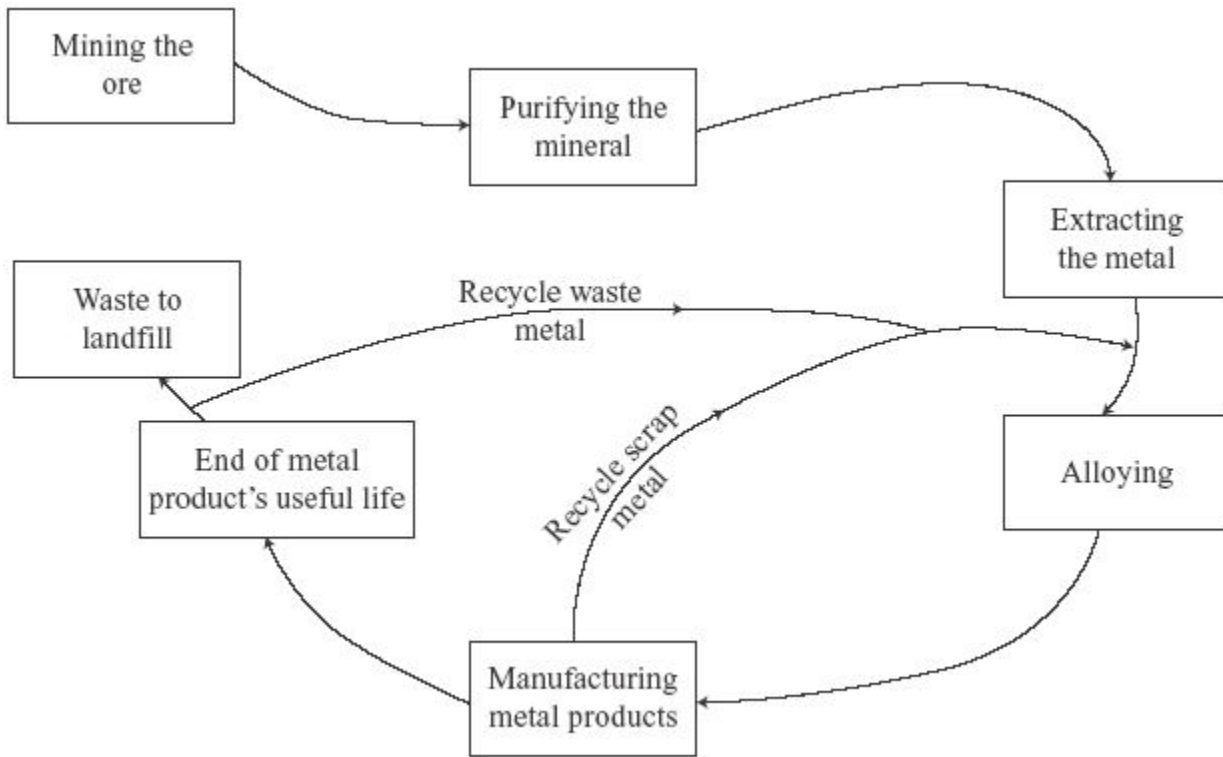
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.....

.....

(3)

(c) The diagram shows the way in which iron is extracted, used and recycled.



Explain why the recycling of iron is necessary for sustainable development.

.....

.....

.....

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.....

.....

.....

(3)  
(Total 10 marks)

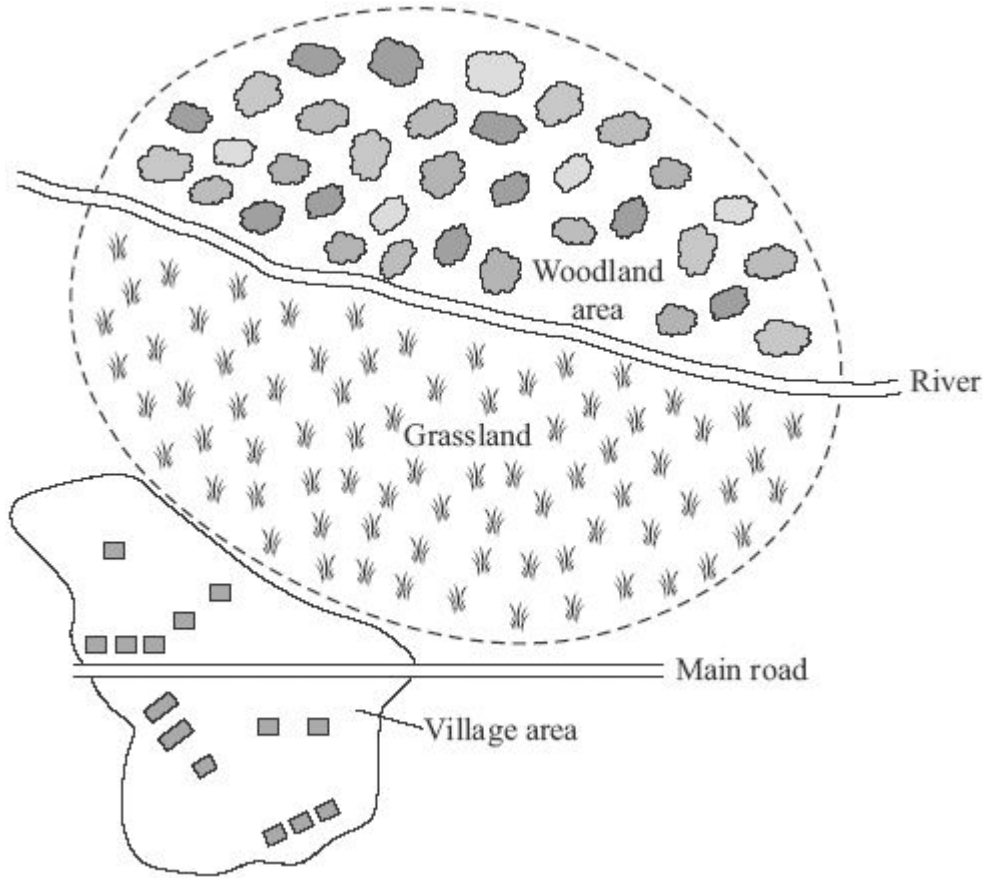
42

Iron ore is the main source of iron.

(a) This was the headline in a newspaper.

## ‘Village protests against quarry’

The dotted line ( ---- ) on the map is drawn around the area from which a company wants to quarry iron ore.



(i) Give **one** reason that the company could give for the need to quarry the iron ore.

.....

.....

(1)

- (ii) The people who live in the village do not want the quarry because it would decrease the value of their homes.

Suggest **two** other reasons why the villagers do not want the quarry.

1 .....

.....

2 .....

.....

(2)

- (b) Iron ore contains the compound iron oxide,  $Fe_2O_3$ .

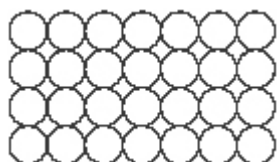
- (i) Iron is extracted from its oxide in the blast furnace.

Complete the word equation for the extraction of iron.

iron oxide + ..... → iron + carbon dioxide

(1)

- (ii) This diagram represents pure iron.



Use the diagram to explain why pure iron is described as an element.

.....

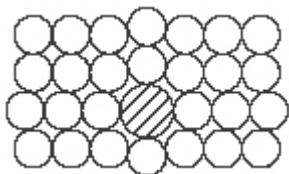
.....

.....

.....

(2)

- (iii) Pure iron is relatively soft. The iron from the blast furnace is hard and brittle. The diagram below represents iron from the blast furnace.



Use the diagram to explain why iron from the blast furnace is hard and brittle.

.....

.....

.....

.....

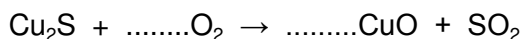
(2)  
(Total 8 marks)

**43**

Copper is a widely used metal. The main ore of copper contains copper sulfide. Copper can be extracted from copper sulfide in a three stage process.

- (a) In the first stage of extraction the copper sulfide is heated in air.

- (i) Balance the symbol equation for the reaction.



(1)

- (ii) Explain why there would be an environmental problem if the gas from this reaction were allowed to escape into the atmosphere.

.....

.....

.....

.....

(2)

- (b) In the second stage copper oxide,  $\text{CuO}$ , is reduced using carbon.

Describe and explain what happens during this reaction.

.....

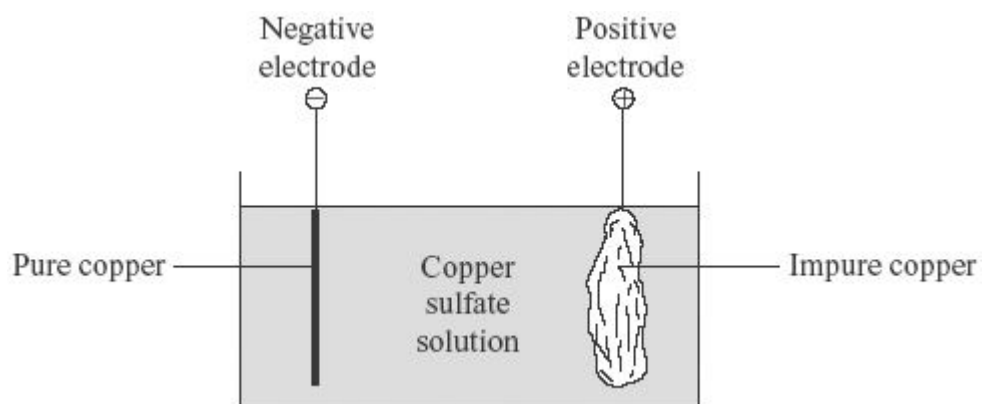
.....

.....

.....

(2)

- (c) During the third stage the copper can be purified as shown in the diagram.



- (i) What is the name of the type of process used for this purification?

.....

(1)

- (ii) Give **one** use of purified copper.

.....

(1)



- (d) Copper-rich ores are running out.

New ways of extracting copper from low grade ores are being researched.

Recycling of copper may be better than extracting copper from its ores.

Explain why.

.....

.....

.....

.....

.....

.....

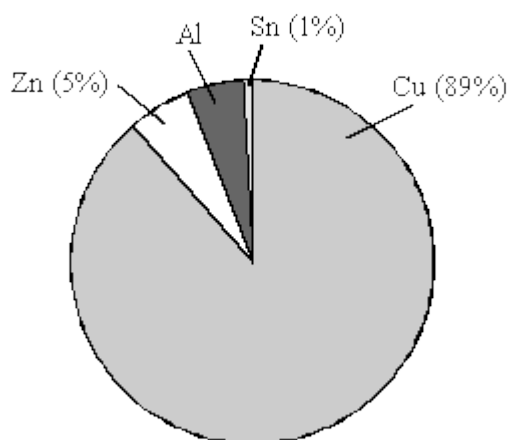
(3)  
(Total 10 marks)

44

The 50 Eurocent coin is made from an alloy called 'Nordic Gold'.



The pie chart shows the percentage by mass of each metal in 'Nordic Gold'.



- (a) (i) Calculate the percentage of aluminium, Al, in the coin.

.....

(1)

- (ii) The 50 Eurocent coin has a mass of 7 grams.  
Calculate the mass of zinc, Zn, in this coin.

.....  
.....

Mass of zinc = ..... g

(2)

- (b) Zinc is extracted by removing oxygen from zinc oxide.

- (i) What name is given to a reaction in which oxygen is removed from a substance?

.....

(1)

- (ii) Explain how oxygen can be removed from zinc oxide to make zinc. Use the reactivity series on the Data Sheet to help you.

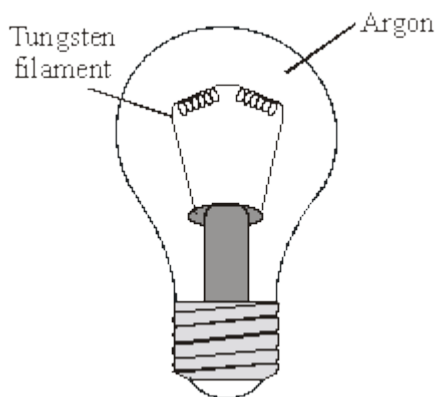
.....  
.....  
.....

(2)

(Total 6 marks)

45

The diagram shows an electric light bulb.



When electricity is passed through the tungsten filament it gets very hot and gives out light.

- (a) What reaction would take place if the hot tungsten was surrounded by air?

.....  
.....  
.....

(1)

- (b) State why argon is used in the light bulb. Explain your answer in terms of the electronic structure of an argon atom.

.....

.....

.....

.....

.....

.....

(3)  
(Total 4 marks)

46

The table gives information about some metals.

Name of the metal	Cost of one tonne of the metal in December 2003 (£)	Percentage of the metal in the crust of the earth (%)
Aluminium	883	8.2
Platinum	16720000	0.0000001
Iron	216	4.1
Gold	8236800	0.0000001

- (a) Use information in the table to suggest why gold and platinum are very expensive metals.

.....

.....

(1)

- (b) Aluminium and iron are made by *reduction* of their ores.

- (i) Name the element that is removed from the ores when they are *reduced*.

.....

(1)

- (ii) Use the reactivity series on the Data Sheet to suggest a metal that would reduce aluminium ore.

.....

(1)

(c) Aluminium is made by the reduction of molten aluminium ore, using a very large amount of electricity.

(i) How is iron ore reduced in a blast furnace to make iron?

.....  
.....  
.....  
.....

(2)

(ii) Suggest why aluminium is more expensive than iron.

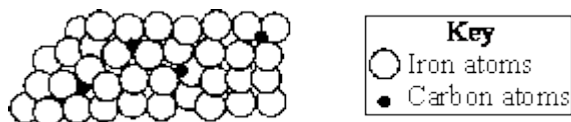
.....  
.....

(1)

(Total 6 marks)

47

The diagram shows the arrangement of atoms in an *alloy*.



(a) What is meant by an *alloy*?

.....  
.....

(2)

(b) Name the alloy represented in the diagram.

.....

(1)

(c) Give **one** advantage of using this alloy instead of pure iron.

.....  
.....

(1)

(d) Which elements are used to make brass?

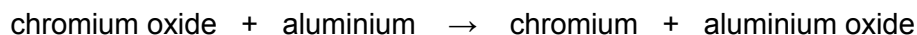
.....

(1)

(Total 5 marks)

**48**

The word equation below shows a reaction used in an industrial process.



The reaction is highly exothermic.

(a) What is an exothermic reaction?

.....  
 .....

(2)

(b) Name the products of this reaction.

.....

(1)

(c) In the reaction one substance is reduced.

(i) Name the substance which is reduced.

.....

(1)

(ii) What happens to the substance when it is reduced?

.....  
 .....

(1)

(Total 5 marks)

**49**

One step in the manufacture of lead is the reduction of lead oxide with carbon. Lead and carbon dioxide are the products of this reaction.

(a) Write a word equation for this reaction.

.....

(1)

(b) What is meant by “reduction”?

.....

(1)

(Total 2 marks)

50

Use the Reactivity Series of Metals on the Data Sheet to help you to answer this question.

The table gives information about the extraction of some metals.

Metal	Date of discovery	Main source	Main extraction method
Gold	Known to ancient civilisations	In the Earth as the metal itself	Physically separating it from the rocks it is mixed with
Zinc	1500	Zinc carbonate	Reduction by carbon
Sodium	1807	Sodium chloride	Electrolysis

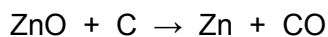
(a) Explain why gold is found mainly as the metal itself in the Earth.

.....

.....

(1)

(b) One of the reactions involved in producing zinc is represented by this equation.



Explain why carbon can be used to extract zinc.

.....

.....

(1)

- (c) Sodium is one of the most abundant metals on Earth.

Explain, as fully as you can, why sodium was not extracted until 1807.

.....

.....

.....

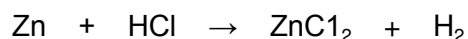
.....

(2)  
(Total 4 marks)

51

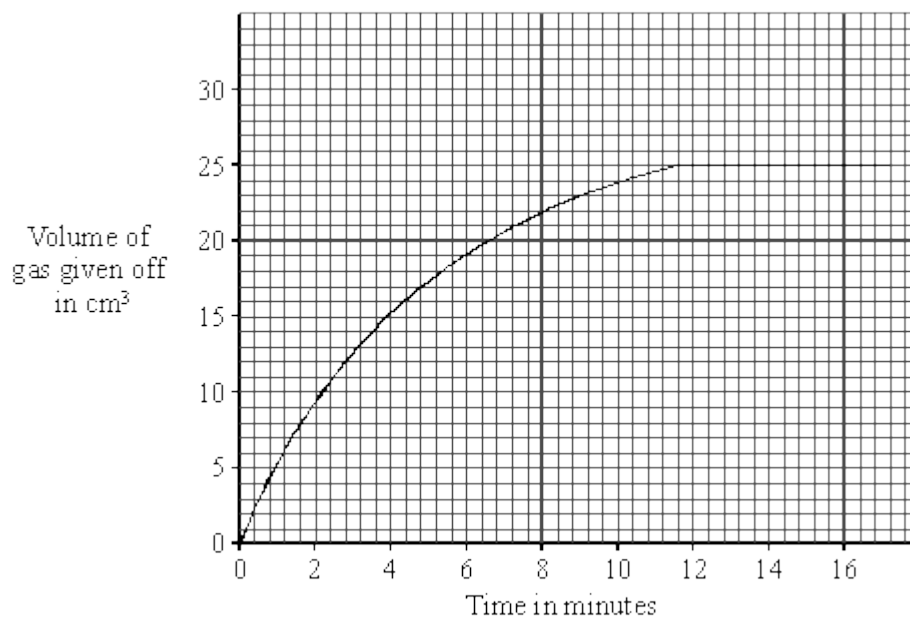
Zinc powder normally reacts slowly with hydrochloric acid.

- (a) Balance the symbol equation for the reaction.



(1)

The graph shows the results from a reaction of 1.0 g of zinc powder with 20 cm<sup>3</sup> of dilute hydrochloric acid. It gives off a gas and forms zinc chloride, ZnCl<sub>2</sub>. Some unreacted zinc is left at the end.



- (b) Copper powder is a good catalyst for the reaction of zinc with hydrochloric acid.
- (i) A mixture of 10 cm<sup>3</sup> of the same dilute hydrochloric acid and 1.0 g of copper powder was added to 1.0 g of zinc powder. What is the maximum volume of gas which could be given off?

..... cm<sup>3</sup>

(1)

- (ii) Draw a graph, on the axes above, for an experiment where 20 cm<sup>3</sup> of the same dilute hydrochloric acid was added to 1.0 g of copper powder mixed with 1.0 g of zinc powder. (2)
- (iii) Give **two** other ways the reaction described in part (i) could be made to go faster. (2)
1. ....
2. ....
- (c) Copper powder can be formed by adding copper sulphate solution to the mixture of zinc powder and acid.
- (i) Why does zinc react with copper sulphate solution to produce copper? (1)
- .....
- .....
- (ii) Write the word equation for the reaction. (1)
- .....
- (Total 8 marks)

52

Part of the Periodic Table showing the symbols for the first twenty elements is given below.

		H						He	
Li	Be			B	C	N	O	F	Ne
Na	Mg			Al	Si	P	S	Cl	Ar
K	Ca	Transition metals							

- (a) Draw diagrams showing the arrangement of electrons (electronic structures) in:
- (i) an aluminium atom;



(ii) a chlorine atom.

(2)

(b) (i) Use electronic structures to help you show why the formula of sodium oxide is  $\text{Na}_2\text{O}$ .

(3)

(ii) State why the formation of sodium ions is classified as an oxidation.

.....

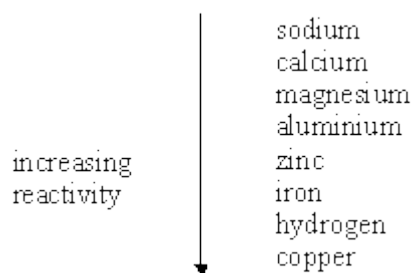
.....

(1)

(Total 6 marks)

53

Part of a reactivity series is:



(a) Carbon is used in blast furnaces to obtain iron and zinc from their oxides, but electrolysis has to be used to obtain aluminium from its oxide.

Draw an arrow on the reactivity series above to show where carbon fits into the series.

(1)

(b) Predict the method of extraction used to obtain calcium from its ore and explain your answer.

.....  
.....  
.....

(2)

(c) The formula for zinc oxide is ZnO. Write a balanced equation for the extraction of zinc in the blast furnace.

.....

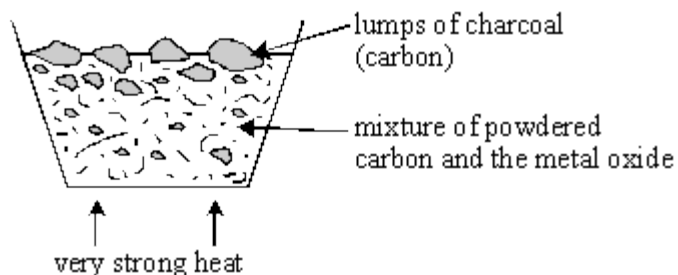
(2)

(Total 5 marks)

54

A student was trying to extract the metals from lead oxide and aluminium oxide.

She heated each oxide with carbon in a fume cupboard as shown below.



She was able to extract lead from lead oxide but not aluminium from aluminium oxide.

(i) Explain the results of these experiments.

.....  
.....  
.....  
.....  
.....

(ii) Complete this word equation for the reaction between lead oxide and carbon.



(Total 5 marks)

**55**

Choose gases from this list to complete the word equations below.

carbon dioxide                  hydrogen                  nitrogen  
oxygen                                  sulphur dioxide

(a) sodium + water → sodium hydroxide + .....

(1)

(b) magnesium + ..... → magnesium oxide.

(1)

**(Total 2 marks)****56**

Here is the word equation for a chemical reaction.

magnesium + zinc oxide → magnesium oxide + zinc

Write down everything that the word equation tells you about the reaction.

.....  
.....  
.....  
.....

**(Total 4 marks)****57**

Cassiterite is an ore of the metal tin.

(a) What is an ore?

.....  
.....

**(2)**

(b) Some metals are obtained by removing oxygen from the metal oxide.

What name do we give to this chemical reaction?

.....

(1)

(c) Name **one** metal which must be extracted from its melted ore by electrolysis rather than by using carbon.

.....

(1)

**(Total 4 marks)**