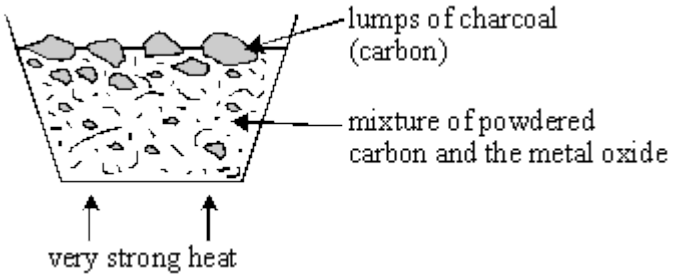
1 A student was trying to extract the metals from lead oxide and aluminium oxide.

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.

lead oxide + carbon → _____ + _____

(Total 5 marks)

2 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.

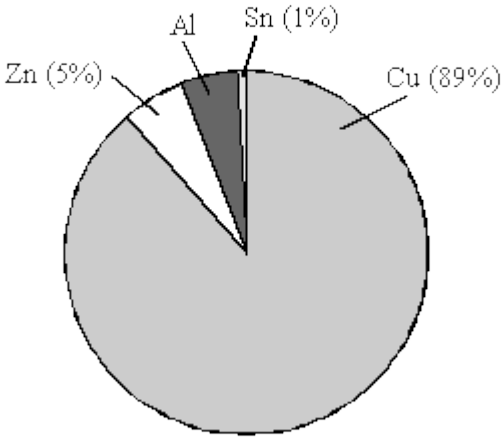
_____

(1)

(Total 4 marks)

3 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)

_____

_____

_____

_____

(2)

(Total 6 marks)

4 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)

5 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.

$ZnO + C \rightarrow Zn + CO$

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.

_____

_____

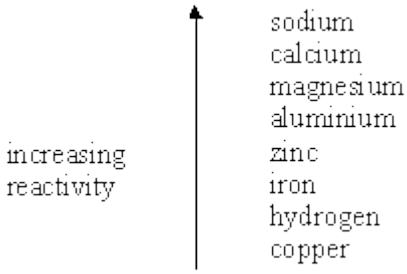
_____

_____

(2)

(Total 4 marks)

6 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)

7 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)

8 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)

9 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^3 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
	Measuring cylinder
Mass of metal powder	
	Ruler
	Burette
Volume of metal sulfate	
	Theromometer
	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 (Fe_2O_3).

Iron oxide is reduced to produce iron.

Balance the equation for the reaction.

___Fe_2O_3 + ___C → ___Fe + ___CO_2

(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)

10 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.

Metal	Metal ore	Purified ore	% of metal in the ore	% of metal in the Earth's crust
aluminium	bauxite	aluminium oxide, Al_2O_3	28.0	8.0
copper	chalcocite	copper sulfide, Cu_2S	0.5	0.001
iron	haematite	iron oxide, Fe_2O_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.

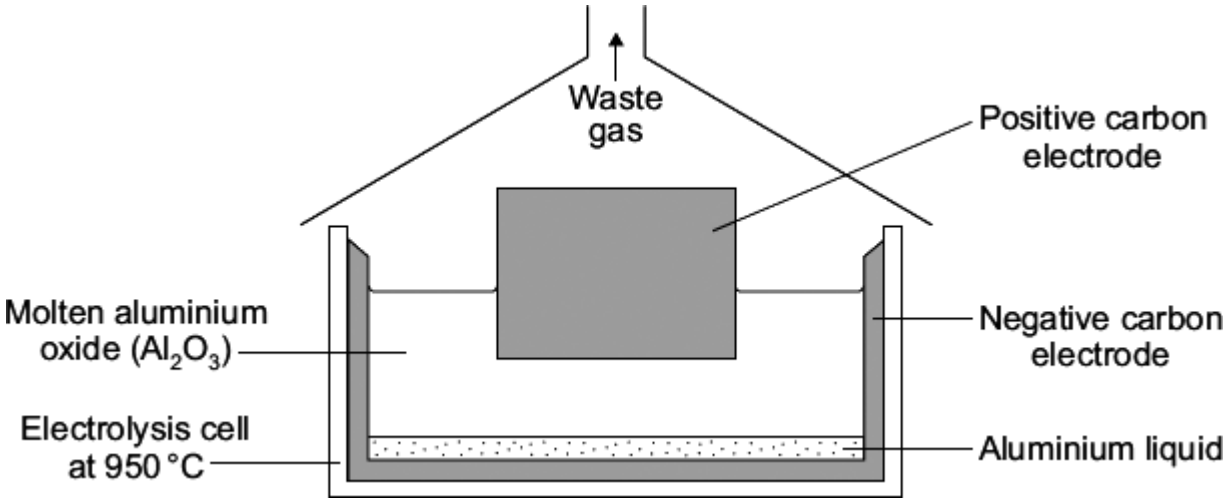
_____

_____

_____

(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)

11 Iron is extracted from its ore.

(a) Iron ore is quarried.

Photograph supplied by Stockbyte/Thinkstock

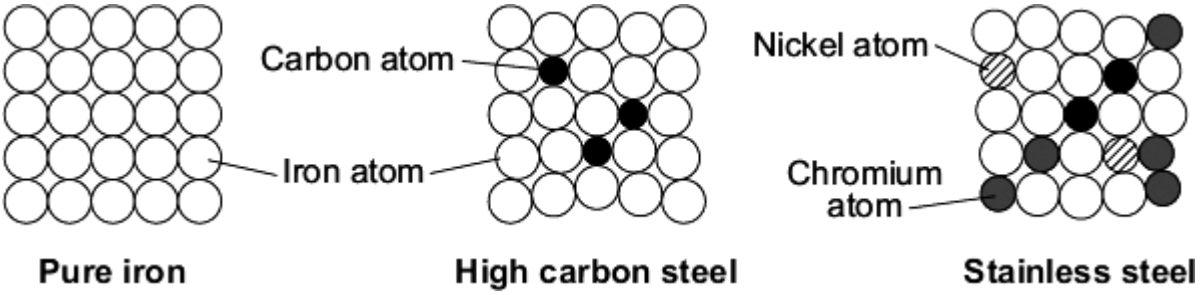
Quarrying iron ore has impacts that cause environmental problems.

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)

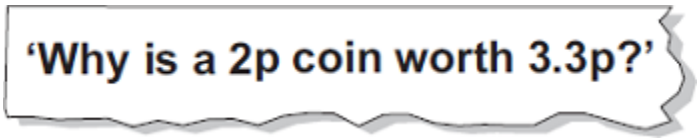
(iii) Stainless steel is used to make cutlery because it

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

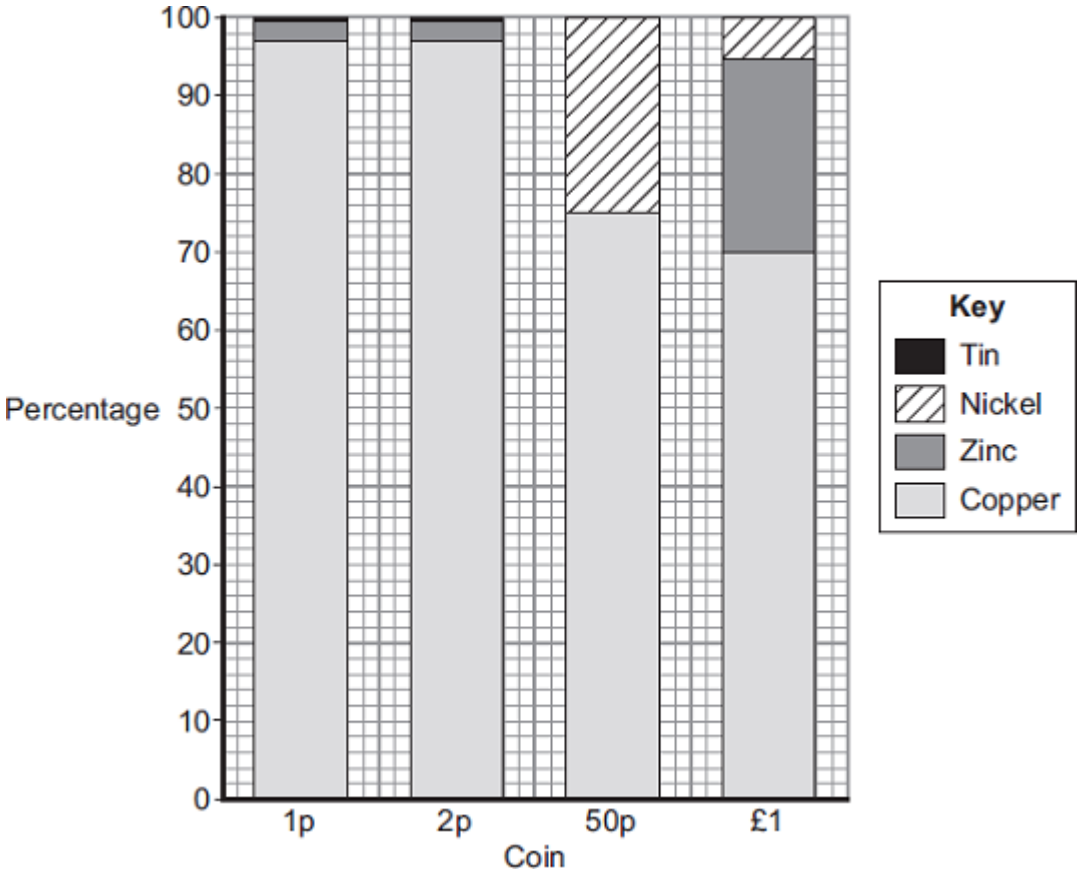
(1)

(Total 7 marks)

12 This is the headline from a newspaper:



(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.

_____

_____

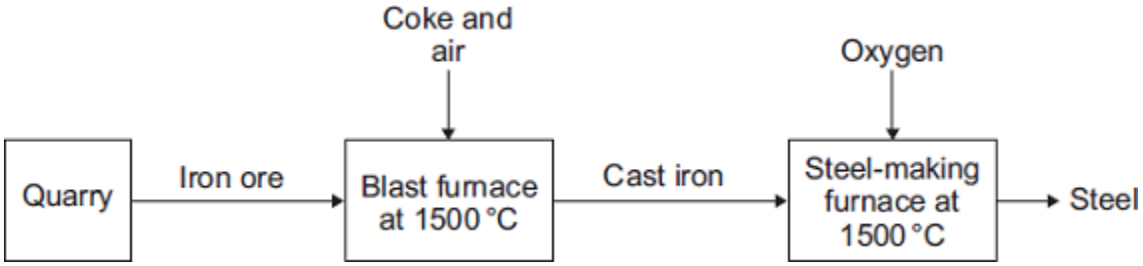
_____

(1)

(Total 5 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.

_____

_____

(1)

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

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(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.

Statement	Advantage Tick (✓)	Disadvantage Tick (✓)
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 Where copper ore has been mined there are areas of land that contain very low percentages of copper compounds.

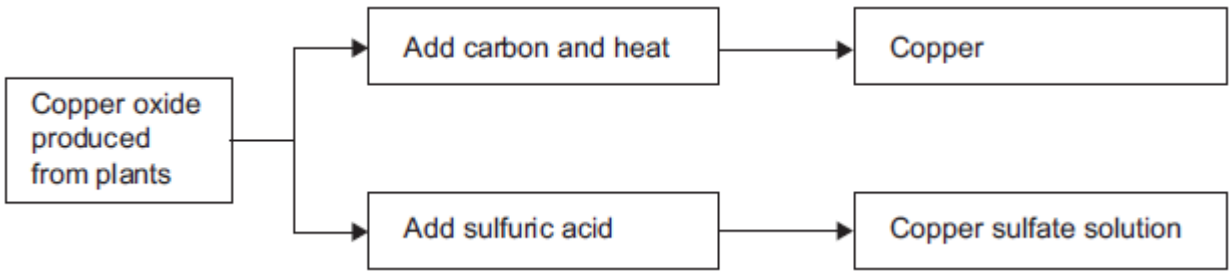
One way to extract the copper is to grow plants on the land.

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.

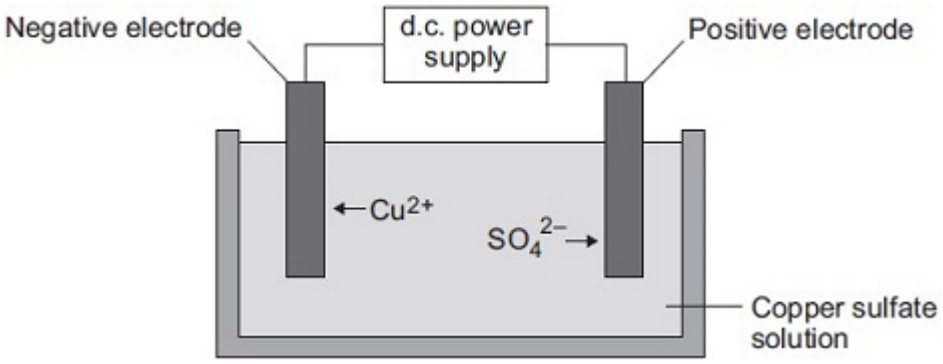
(i) Complete the word equation.

copper sulfate + iron ⟶ _____ + _____

(2)

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

Figure 2



Why do copper ions go to the negative electrode?

_____

_____

(1)

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

_____

_____

_____

_____

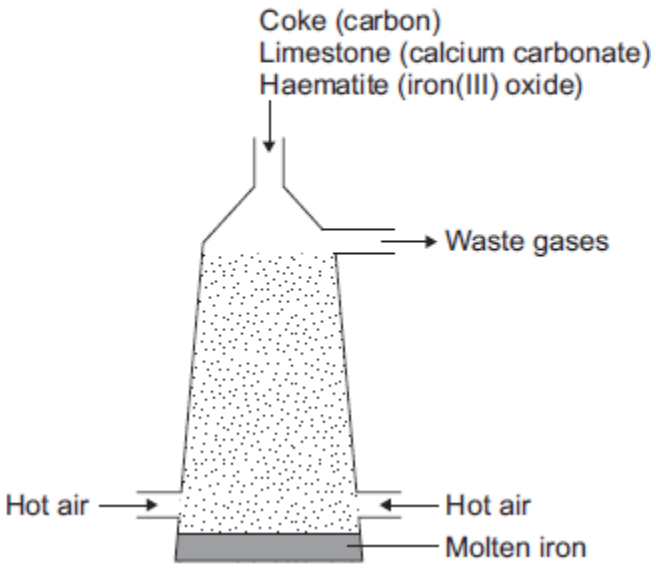
(2)

(Total 8 marks)

15 This question is about iron and aluminium.

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

Figure 1



(i) Calcium carbonate decomposes at high temperatures.

Complete the word equation for the decomposition of calcium carbonate.

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.

$$C(s) + CO_2(g) \longrightarrow \_\_\_\_\_\ CO(g)$$

(1)

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

$$Fe_2O_3(s) + 3\ CO(g) \longrightarrow 2\ Fe(s) + 3\ CO_2(g)$$

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

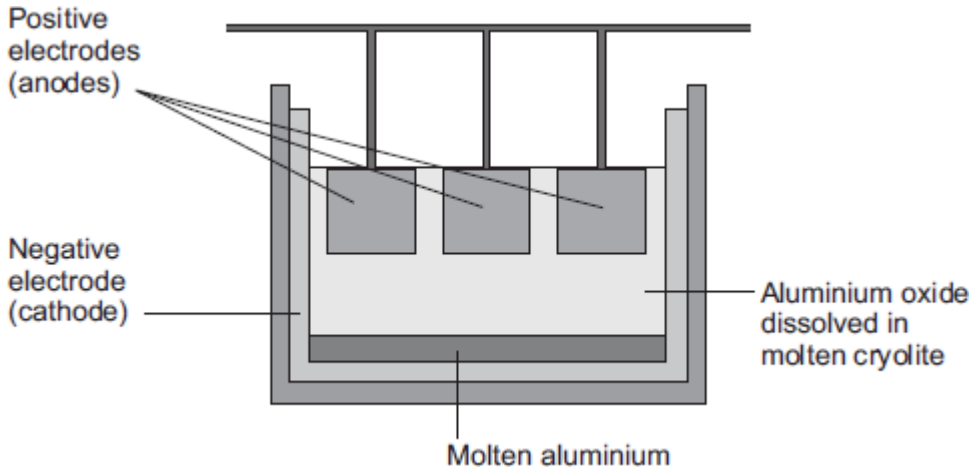
Relative atomic masses (A_r): O = 16; Fe = 56

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.

(3)

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

(3)

(Total 13 marks)

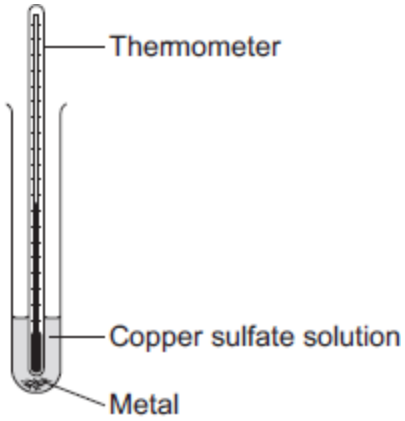
16 A student investigated displacement reactions of metals.

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. _____

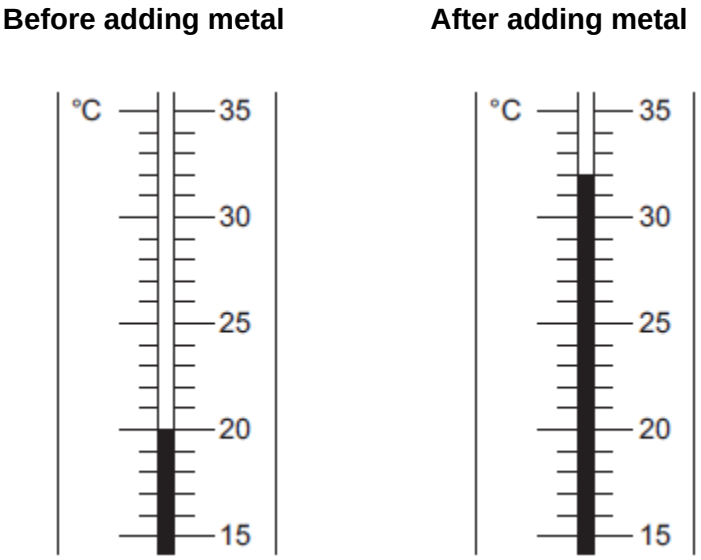
2. _____

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



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.

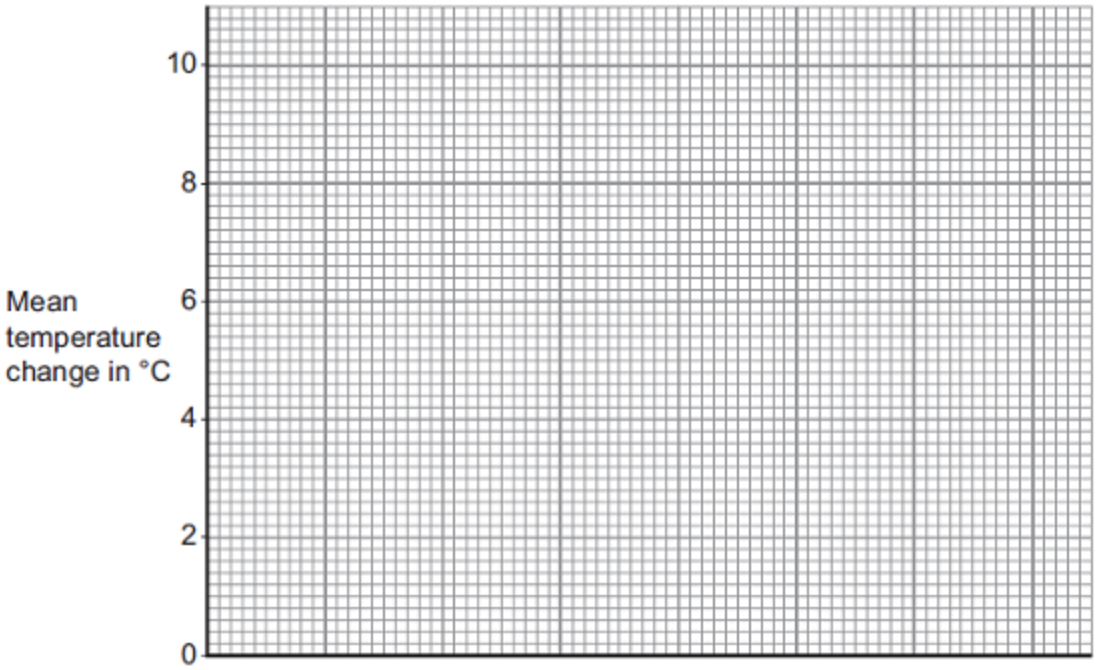
Table 2 shows the mean temperature change for each metal.

Table 2

Metal	Mean temperature change in °C
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.

_____

_____

_____

_____

_____

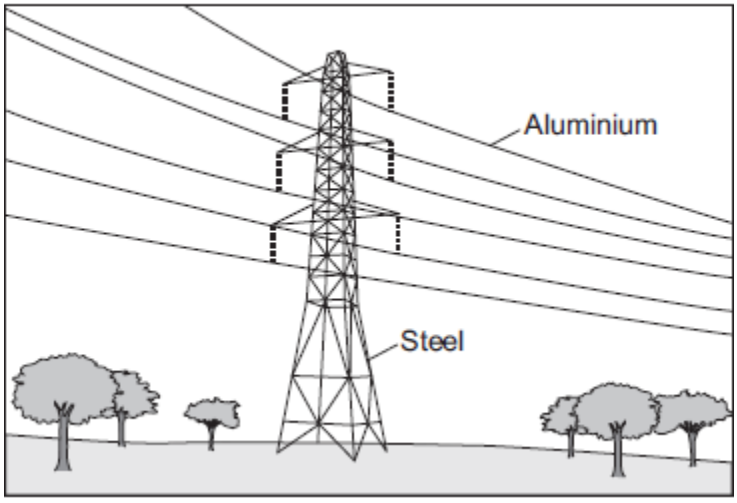
(2)

(Total 16 marks)

17 This question is about metals.

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

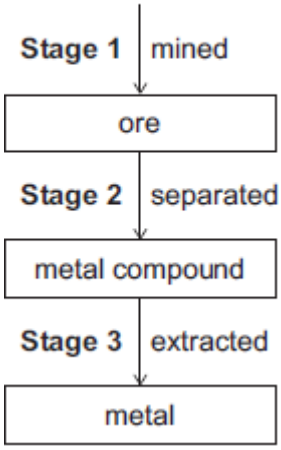
Figure 1



(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.

(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.

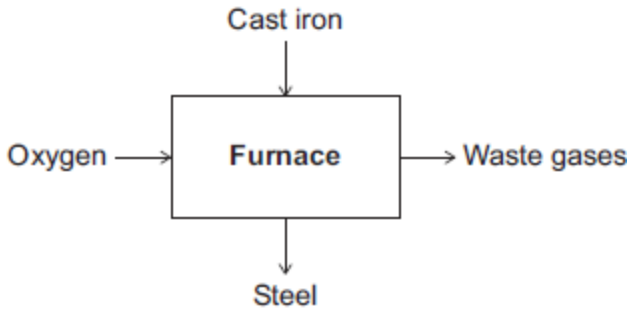
_____

_____

(1)

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

Figure 3



Describe how cast iron is converted into steel.

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

_____

_____

_____

_____

(2)

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

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

_____

_____

(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?

_____

_____

_____

_____

(2)

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

Explain why.

_____

_____

_____

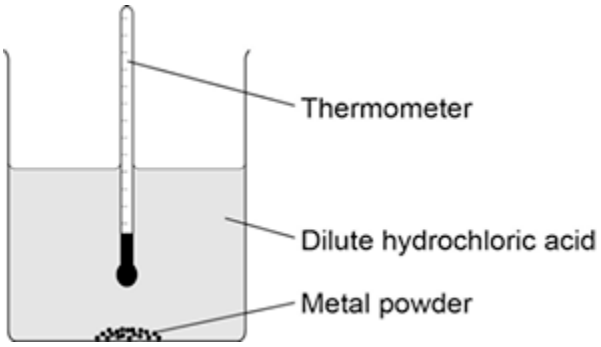
_____

(2)

(Total 10 marks)

18 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?

_____

_____

_____

_____

(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)

Mark schemes

1

(i) idea that:
carbon is above lead in the reactivity series } NOT
for 1 mark

carbon is below aluminium in the reactivity series } OXIDE
for 1 mark

carbon can remove oxygen from/reduce lead <u>oxide</u>
or cannot remove oxygen from aluminium <u>oxide</u>
not aluminium more reactive than lead
for 1 mark

OR similar ideas in comparing bond strengths

3

(ii) (carbon + lead oxide) →*<u>lead</u> + *<u>carbon dioxide</u>
each for 1 mark

accept correct formulae CO_2 and CO **NOT** carbon oxide

2

[5]

2

(a) *ideas that it is a*

- compound of metal/metal oxide/combined (NOT mixed) cpd/ named cpd O^{2-}/S^{2-}/CO_3^{2-} etc
- found naturally/in rocks/in Earth's Crust

for 1 mark each

2

(b) reduction (accept smelting/refining but <u>not</u> electrolysis)
for 1 mark

1

(c) One example. Al or above in Reactivity Series
ie Group I or II metals NOT Pb/Cu or compounds
for 1 mark

1

[4]

3 (a) (i) 5(%)

1

(ii) 0.35

$\frac{5}{10} \times 7$

for 1 mark

2

(b) (i) reduction

accept (it's) reduced

*do **not** accept redox / deoxidation*

1

(ii) heat with / reduce / react with **or** (chemical) reaction

1

with a metal / element / substance higher in reactivity

ignore displace
*accept higher named elements **or** symbol*
accept carbon monoxide / coal / coke

*correct word equation for **2** marks*
*correct formulas for **1** mark*
*correct balanced symbol equation for **2** marks*

1

or

electrolysis:

molten (1)
electrolysis (1)

[6]

4 (a) hydrogen

for 1 mark

1

(b) oxygen

for 1 mark

1

[2]

5 (a) unreactive / near bottom of reactivity series

1

(b) carbon more reactive / higher up reactivity series

1

(c) very reactive / near top of reactivity series

1

cannot use displacement methods / can only be extracted by electrolysis / had to wait discovery of electricity

1

[4]

6 (a) An arrow indicating a position between aluminium and zinc.

1

(b) electrolysis

1

because calcium is more reactive (than aluminium **or** carbon)

accept it is more reactive
or *very reactive*

1

OR

in a blast furnace

1

because calcium is less reactive (than carbon **or** lower)

1

(c) any equation from

1 mark for correct formulae
1 mark for balancing

$2ZnO + C \rightarrow 2Zn + CO_2$

$ZnO + CO \rightarrow Zn + CO_2$

$ZnO + C \rightarrow Zn + CO$

1

[5]

7 (a) (very) small percentage / amount (in the Earth's crust)

any indication that there is a small amount, eg not much (left)
accept rare (elements) / rarer
accept not commonly found
ignore cannot find easily
ignore hard to extract

1

(b) (i) oxygen / O_2 / O

*do **not** accept* O^{2}

1

(ii) any **one** from:

- potassium / K
- sodium / Na
- calcium / Ca
- magnesium / Mg

symbols must be correct
write name and incorrect symbol,
ignore symbol

1

(c) (i) heating (with) **or** hot air blown into furnace

accept high temperatures or (very) hot

1

carbon / carbon monoxide / coke / coking coal

*do **not** accept coal / charcoal accept balanced equation only*

or
carbon reacts with O_2 **or** carbon / coke burning (1)

accept balanced equation only CO / CO_2

CO reacts with the ore (1)

for naming the reducing agent

1

(ii) cost of melting ore / electricity
makes aluminium expensive (owtte)
or (large amount of) electricity used
or because you have to use electrolysis
or aluminium is higher in the reactivity series
or aluminium is harder to <u>reduce</u>
or unable to reduce with carbon
or the cost of purifying the bauxite

*do **not** accept harder to extract / produce*
*more energy is **not** enough*

1

[6]

8 (a) lead oxide + carbon = lead + carbon dioxide
(A symbol equation was accepted if correct)

1

(b) oxygen removed (or addition of electrons)

1

[2]

9

(a) Whether there was a reaction or not

1

(b) brown / orange / dark deposit on zinc
or
blue solution turns colourless / paler

1

(c)

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

more than one line drawn from a variable negates the mark

2

(d) (Most reactive) **Magnesium**
Zinc
(Least reactive) **Copper**
must all be correct

1

(e) would not be safe **or**

too reactive
allow too dangerous

1

(f) Gold

1

(g) $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$
allow multiples

1

(h) carbon

1

(i) Loss of oxygen

1

[10]

10 (a) (i) low percentage / very little of metal (in the ore)

*accept only 0.5% metal in the ore **or** over 99% waste in the ore **or** nearly 100% waste in the ore*

*ignore reference to percentage of metal in the Earth's crust **or** energy used or pollution*

1

(ii) any **one** from

(it = iron)

- iron uses less energy / fuel for extraction

  ignore electrolysis / uses electricity / reactivity

- iron has more uses

- more demand for iron

  ignore high abundance in the Earth's crust / high percentage of metal in ore

- iron is stronger

  ignore harder

- cheaper / costs less

- easier to extract

1

(b) (i) has melting point lower than 950°C

(it = aluminium)

allow has a low melting point

ignore boiling point

1

(ii) electrode(s) made of carbon

1

oxygen reacts with electrode(s) / carbon

accept $C + O_2 (\rightarrow CO_2)$

*NB oxygen reacts with the carbon electrode(s) = **2** marks*

1

(iii) any **two** from:

- saves resources / non-renewable
  *accept aluminium / ore will run out **or** conserves aluminium*
- landfill problem
  accept aluminium does not corrode
- saves energy / fuel / electricity
  ignore global warming
- less carbon dioxide / carbon emissions **or** reduces carbon footprint
  ignore consequences of quarrying / mining
- less quarrying / mining
  ignore pollution / harms environment / costs / easy to recycle

2

[7]

11 (a) causes dust pollution

1

increases traffic

1

(b) (i) it is soft

accept the layers of atoms can slide over each other
ignore other properties

1

(ii) contains chromium / nickel

allow contains other <u>metals</u>

1

(c) (i) an element

1

(ii) hard

1

(iii) is resistant to corrosion

1

[7]

12 (a) (i) copper / Cu

1

(ii) 50 (p)

1

(iii) 25

1

(iv) tin

1

(b) any **one** form:

- high cost of copper
  allow metal is expensive
- less copper available **or** (copper ores exhausted / **only** low-grade ores available)
  allow copper is non-renewable
- high demand for copper
- high percentage (%) of copper in the coin
- inflation (of cost)

1

[5]

13 (a) (i) Positive impact

any **one** from:

- provides employment **or**
- improves local economy
- improved transport - new roads are built, new rail links
- after use the quarry could provide recreation facilities

1

Negative impact

any **one** from:

- destruction of animal habitats
- fewer plants and trees to absorb carbon dioxide
- visual pollution **or** noise pollution **or** atmospheric / air pollution
  allow dust pollution
- more traffic
- uses non-renewable resources
  allow pollutants from burning diesel

1

(ii) economical

1

(b) carbon / coke burns (in oxygen / air)

accept carbon / coke reacts with oxygen / air

1

(c) (i) iron oxide (reactant)

must be words

1

carbon dioxide (product)

1

(ii) reduction

1

(d) (i) oxygen reacts with carbon

1

or

oxygen and carbon produce carbon dioxide / carbon monoxide

carbon dioxide / carbon monoxide is a gas

or

the carbon is removed as a gas

1

(ii) much harder

1

(e) Advantage:

less carbon dioxide is produced

1

Disadvantage:

there are different types of steel which must be sorted

1

[12]

14 (a) (i) economical

1

(ii) phytomining

1

(iii) carbon dioxide

1

(b) (i) copper / Cu

1

iron sulfate / $FeSO_4$

1

(ii) copper / ions have a positive charge

it = copper ions

allow copper ions have a different charge

accept copper / ions are free to move

accept to gain electrons

accept copper / ions are attracted to the negative electrode ***or*** *opposite charges attract*

1

(c) any **two** from:

ignore not biodegradable or does not decay

- copper ores are limited / running out

  allow copper is running out
- copper can be recycled
- copper can be reused
- copper is expensive
- landfill sites are filling up
- copper compounds are toxic

  allow copper is toxic

2

[8]

15 (a) (i) calcium oxide

in either order

1

carbon dioxide

accept correct formulae

1

(ii) $C(s) + CO_2(g) \rightarrow \mathbf{2}CO(g)$

allow multiples

1

(iii) 210 (tonnes)

award ***3*** *marks for the correct answer with or without working*

allow ecf for arithmetical errors

if answer incorrect allow up to ***2*** *marks for any of the steps below:*

160 → 112

300 → 112 / 160 × 300

or

moles Fe_2O_3 = 1.875 (× 10^6) or 300 / 160

moles of Fe = 3.75 (× 10^6) or 2 × moles Fe_2O_3

mass Fe = moles Fe × 56

105 (tonnes) scores 2 (missing 1:2 ratio)

420 (tonnes) scores 2 − taken M_r of iron as 112

3

(b) (i) aluminium is more reactive than carbon **or** carbon is less reactive than aluminium

must have a comparison of reactivity of carbon and aluminium

accept comparison of position in reactivity series.

1

(ii) (because) aluminium ions are positive

ignore aluminium is positive

1

and are attracted / move / go to the negative electrode / cathode

1

where they gain electrons / are reduced / $Al^{3+} + 3e^- \rightarrow Al$

accept equation or statements involving the wrong number of electrons.

1

(iii) (because) the anodes **or** (positive) electrodes are made of carbon / graphite

1

oxygen is produced (at anode)

1

which reacts with the electrodes / anodes

*do **not** accept any reference to the anodes reacting with oxygen from the air*

*equation $C + O_2 \longrightarrow CO_2$ gains **1** mark (M3)*

1

[13]

16 (a) any **three** from:

- concentration of (salt) solution
- volume of (salt) solution

  ignore amount of solution
- **initial** temperature (of the solution)

  ignore room temperature
- surface area / form of metal
- moles of metal

  allow mass / amount

  ignore time

  ignore size of tube

3

(b) 20

1

32

1

12

allow ecf

1

(c) (i) four bars of correct height

tolerance is + / - half square

*3 correct for **1** mark*

2

bars labelled

1

(ii) *one variable* is non-continuous / categoric

accept qualitative or discrete

accept no values between the metals

1

(iii) magnesium

1

because biggest temperature change

accept gives out most energy

ignore rate of reaction

dependent on first mark

1

(iv) does not react / silver cannot displace copper

1

because silver not more reactive (than copper) **or** silver below copper in reactivity series

*do **not** accept silver is less reactive than copper sulfate*

1

(v) replace the copper sulfate

could be implied

1

with any compound of a named metal less reactive than copper

allow students to score even if use an insoluble salt

1

[16]

17 (a) The ore is not pure or contains impurities or the ore does not contain 100% of the metal compound

allow to concentrate the metal or metal compound

1

rock / other compounds need to be removed / separated

1

(b) (i) (cast iron is) brittle

allow not strong

ignore weak

1

(ii) the oxygen reacts with carbon

allow carbon burns in oxygen or is oxidised

1

reducing the percentage of carbon in the mixture
or producing carbon dioxide

1

(c) (i) aluminium has a low density

1

(ii) (because copper) is in the central / middle (block of the periodic table)

1

whereas aluminium is in Group 3 (of the periodic table)

1

(iii) iron is more reactive (than copper)

ignore cost

1

so copper is displaced / reduced

1

[10]

18 (a) any **two** from:

- concentration / volume of dilute hydrochloric acid
- mass of metal powder
- surface area of metal powder
- stirring (of any) / rate of stirring

allow reacted for the same length of time

2

(b) 4.2 °C

allow Magnesium Test 2

1

and any **one** from:

- lower mass of magnesium added
- surface area of magnesium too low
- magnesium coated in magnesium oxide (so took a while to start reacting)
- not stirred
- not stirred as quickly as the other metals
- not reacted for as long a time as the other metals

allow reason for break in circuit

1

(c) 17.4(°C)

1

(d) bubbles of gas

1

more (bubbles) seen with calcium than other metals

allow any correct comparison between two metals

1

(e) any value between 7.9 °C and 12.3 °C

1

[8]

Examiner reports

1 Most candidates incorrectly compared the reactivity of lead with aluminium rather than lead with carbon and then carbon with aluminium.

Most candidates correctly completed the equation but some lost marks by giving carbon oxide.

2 **Paper I4**

This question was poorly answered. Most candidates found it difficult to describe an ore. The few good answers noted that it was a compound of a metal found naturally in rocks. Many candidates incorrectly thought that the removal of oxygen was oxidation rather than reduction. Whilst in (c) most candidates gave either lead or iron rather than a reactive metal like aluminium or sodium.

Paper H6

(a) Full marks were surprisingly seldom gained for this seemingly simple item. Relatively few candidates referred to the metals in ores being combined with other elements as compounds.

(b) “Reduction” was the response of a disappointingly small proportion of candidates; “oxidation” or “de-oxidation” were common responses.

(c) Many candidates suggested copper or iron as metals which could not be extracted from their ores using carbon.

3 **Foundation Tier**

(a) Most candidates completed part (i) correctly but many found difficulty with part (ii). A number of candidates gave no working for part (ii), which was fine if they have the correct answer but meant that they gained no marks if they made a calculation error.

(b) (i) A surprising number of candidates gave oxidation rather than reduction for this question. A number of candidates gave de-oxidation.

(ii) Candidates often found this part quite difficult. Some candidates lost the second mark because they gave an answer such as ‘add carbon to zinc oxide’. They were required to indicate that a reaction between carbon and zinc oxide is needed. Thus answers such as ‘react / heat zinc oxide with carbon’ would gain both marks. A large number of candidates thought that zinc could be made by simply heating zinc oxide and gained no marks.

Higher Tier

This question was very well answered by the candidates and allowed them to gain in confidence. The majority of candidates scored full marks.

(a) These calculations were done well by the candidates.

(b) (i) A fair number of candidates thought that removal of oxygen was oxidation. 'Redox' did not receive credit.

(ii) This part was usually very well answered, and most candidates were able to name a suitable reagent. A significant minority simply said that this reagent was to be 'used with', 'mixed with' or 'added to' zinc oxide, rather than stating 'react with' or 'heat with'.

4 Only better candidates were able to consistently select correct answers. Other attempts appeared to be guesswork.

5 Most candidates showed a good understanding of the Reactivity Series in parts (a) and (b). Although many mentioned electrolysis in (c), they did not always link it to the high reactivity of sodium.

6 Because of the error in the direction of the arrow in the reactivity series, parts (a) and (e) were declared void and were not marked. The arrow of increasing reactivity being reversed did not seem to disadvantage any candidate. From the (correct) responses to answers, many candidates probably did not realise the arrow was the wrong way. They were given credit for answers to other parts of the question based on logical deductions from the given information, as well as correct chemistry.

7 Part (a) was very well answered. In part (b), very few candidates identified that oxygen is removed during reduction. Part (b)(ii) was often answered correctly even when part (b)(i) was incorrect. A common incorrect answer was carbon.

A fair number of candidates gained a mark in part (c)(i) for the idea of heating the iron ore but few correctly identified the reducing agent. Part (c)(ii) was not well answered, despite the hint in the stem of the question. A simple answer such as the cost of the electricity was all that was required.

10

(a) (i) Many suggestions were incorrectly linked to the amount of copper metal in the Earth's crust; however, several candidates understood that there was very little metal available in the copper ore. A few candidates were more concerned with pollution caused by the waste gases produced from copper sulfide, and made reference to sulfur dioxide and acid rain.

(ii) There was a wide variety of correct suggestions with most candidates stating that iron is 'more useful', 'more in demand', 'cheaper' or 'stronger'. A few candidates correctly stated that iron is 'easier to extract'. However, candidates should be advised to be precise and not to write vague statements, such as, 'easier to get'.

(b) (i) Far too many candidates just stated that it turned into a liquid because 'it is hot' or 'at 950°C'. This was just restating the information in the question. The best answers came from candidates who appreciated that they had to compare the temperature of the electrolysis cell to the melting point of aluminium. Candidates were awarded the mark for suggesting that the aluminium 'melts' or that the temperature in the cell is either at or above the melting point of aluminium. Marks were consistently lost for answers that were otherwise good but where candidates referred to boiling point rather than melting point, for example, 'aluminium has a low boiling point so it melts'.

(ii) This question was poorly answered by candidates. Very few candidates gained two marks for realising that the 'electrode(s) are made of carbon' and that 'carbon reacts with oxygen' to produce carbon dioxide. Most candidates who managed to gain a mark here got it for mentioning that the 'electrode(s) are made of carbon'. There were several common incorrect ideas, these included 'aluminium burns to give off carbon dioxide', 'oxygen burns to form carbon dioxide', 'carbon dioxide is released because of heating' and 'we use up oxygen when we breathe in and breathe out carbon dioxide'.

(iii) The reasons for recycling appeared to be well understood. Most candidates gained at least one mark usually for 'saves resources or aluminium is non-renewable'. There were too many vague answers including 'to save money', 'to reuse', 'less pollution' and 'good for the environment'.

11

(a) The majority of students achieved full marks for identifying the two environmental impacts of quarrying iron ore.

(b) (i) Very few students achieved the mark because they did not know that pure iron is too soft to have many uses. Many gave answers related to pure – 'it only contains iron atoms' or gave incorrect physical properties such as, 'it is a good conductor of heat/electricity' and 'it has a high melting/boiling point'.

(ii) Many students correctly suggested that stainless steel is more expensive than pure iron because other metals, chromium and nickel, are used in stainless steel.

(c) (i) Most students gained the mark for knowing that pure iron is an element.

(ii) A large majority of students understood that high carbon steel must be hard to be used as a drill bit.

(iii) Most students knew that stainless steel is used to make cutlery because it is resistant to corrosion.

12

(a) (i) The majority of students achieved the mark for identifying the metal in all of the coins.

(ii) The majority of students achieved the mark for identifying that zinc is not in the 50p coin.

(iii) Most students used the bar chart to work out that there is 25% nickel in a 50p coin.

(iv) Most answers were correct, stating that copper, zinc and tin were used in 1p and 2p coins.

(b) Most students were unable to gain the mark because they could not give a clear reason why a 2p coin made in 1991 is now worth 3.3p.

13

(a) (i) Most students gained at least one mark. The most common correct answers were 'provides jobs' and a 'specified type of pollution'. There were a number of vague answers that did not describe the impacts and just stated 'pollution' or 'carbon dioxide produced' or 'non-renewable'. A number of students also referred to the process of producing iron or steel instead of the quarrying of iron ore.

(ii) Few students knew that ores contain enough metal to make extraction of the metal economic.

(b) Surprisingly poorly answered because most students thought that 'by coke' or by 'coke and air' were sufficient for the answer. There were a range of interesting responses that did not gain credit such as, the blast furnace is heated by 'the Sun', 'a bunsen burner', 'hot air', 'a flame', 'fire' and 'electrolysis'. Although many students mentioned coke and air, they did not state they react just that they are added. Several students did not mention coke but suggested other fuels such as coal or natural gas as being used to heat the blast furnace.

(c) (i) Many correct answers were given but it is surprising that a significant number of students still could not name iron oxide calling it iron ore and carbon dioxide was often called 'carbonate', 'cobalt' or 'carbon monoxide'.

(ii) Few students understood that iron is extracted from its ore by reduction.

(d) (i) Very few students gained any marks. The most common incorrect idea was that oxygen is stronger so it pushes or blows the carbon out. Most students who got one mark did so for knowing that carbon dioxide is produced. Other incorrect suggestions were that oxygen is more reactive than carbon so removes it by decomposition or by neutralisation or by reduction.

(ii) Most students knew that metals, such as nickel, are added to low-carbon steels to make the steel much harder.

(e) Most students gained at least one mark. The most common correct answer was the advantage that less carbon dioxide is produced. Several students thought that four ticks were needed, that is, one in each row. Many incorrectly thought that the disadvantage was more iron needs to be mined.

14

(a) (i) This part was poorly answered. Most students did not appear to understand that metal ores need to contain enough metal to make extraction of the metal economical.

(ii) Most students achieved the mark for knowing that using plants to extract metals is called phytomining.

(iii) Only a slight majority of students were able to apply their knowledge and correctly choose carbon dioxide as the other product when copper oxide reacts with carbon.

(b) (i) Most students gained one of the two marks for naming the products when copper sulfate reacts with iron. Several gained one mark because they wrote the products as 'copper' + 'sulfate'. The most common incorrect products were carbon dioxide, sulfur dioxide and water. Many students just wrote the names of the reactants in the spaces for the products.

(ii) Most students gained the mark usually for stating that copper ions have a positive charge or that copper ions are attracted to the negative electrode. The most common confused answers were that 'copper ions are negative' or 'copper is a positive electrode so is attracted to the negative electrode'. Some stated that copper ions go to the negative electrode because 'copper is magnetic'.

(c) This was poorly answered. The most common mark for this question was zero. Two common misconceptions about why copper should not be disposed of in landfill sites were that 'copper is harmful because it is reactive' and 'copper is dangerous because it conducts electricity'. The few that gained marks did so by writing about recycling copper, reusing copper, copper is running out or that copper is expensive. One problem was that many of these students do not understand the difference between recycling and reusing.

15

(a) (i) This question was well answered although some students made substances from elements that are not contained in calcium carbonate.

(ii) Almost all students gained this mark. However, a few students added an additional “2” before the carbon or changed the formulae of some of the substances.

(iii) Many fully correct answers were seen to this question. Common errors included excessive rounding or missing the ratio of iron(III) oxide to iron in the equation. As in question 7(e), incorrect answers accompanied by a jumble of random and incorrect working could not be credited but the inclusion of some words in working to say what the numbers represent may make it possible to award marks.

(b) (i) This was well answered. Although most students gave clear answers comparing the reactivity of carbon and aluminium, a few gave answers such as “aluminium is not less reactive than carbon”, which while correct is not the simplest way of expressing the idea. A small number of students used phrases such as “it is more reactive than it” - students should be encouraged to write the correct name rather than “it” as this will help make their meaning clear.

(ii) While many excellent answers were seen, the two most common errors were not stating that aluminium ions are positive and errors or contradictions in explaining the gain of electrons being reduction (comments such as the aluminium ions gain electrons and so are oxidised are not credit worthy).

(iii) The fact that the anodes are made of carbon was known my most students, and that the anodes react with oxygen was also well known. However, the mark that was awarded least often was the one for stating that oxygen is produced at the anode.

16

(a) The most common error was to refer to the ‘amount’ of copper sulfate solution rather than specifically mention concentration or volume. A few students wanted to control the dependent variable by keeping the temperature constant or the independent variable by not changing the metal used.

(b) This was very well answered, with few errors. A very small minority of students transposed digits when calculating the difference.

(c) (i) Most students gained full marks on this question part. The most common error was to have the bar for cobalt at 5 rather than 4.5 or that for tin at 0.5 rather than 1.5. It should be noted that there is no need for students to spend time shading the bars in: a label for each bar will suffice.

(ii) Some students made excellent use of the terms categoric and non-continuous, and clearly knew when a line graph was appropriate. However, a significant number thought that a line graph could not be used either because some of the temperature changes were zero or because there was no pattern to the data.

(iii) This was very well answered.

(iv) Most students scored 1 mark by stating there was no reaction, but many did not then go on to explain why there was no reaction. In questions that ask students to explain ideas must be linked together in order to gain full marks.

(v) Most students realised the problem was the copper sulfate solution and that this needed to be replaced. However, some answers were then vague, just stating use a salt of a metal less reactive than copper, without naming one. The information in the question shows that both silver and gold are less reactive than copper, so a salt of either of these metals would have been suitable.

17

(a) This question required students to study a flow diagram and explain why a metal compound had to be separated from its ore. Most students gained just one mark for stating that the ore contained impurities or that waste materials needed to be removed. Some students confused the separation in stage 2 with the extraction in stage 3, stating that this stage was needed to extract the metal from the ore.

(b) (i) This question was not well answered. Students needed to state that cast iron is brittle, although ‘not strong’ was an acceptable response. Some students referred to other properties of iron such as conductivity or rusting, which was not the specific property relating to the question, and did not gain credit.

(ii) Again this question was not well answered. Students needed to study a flow diagram showing how cast iron is converted to steel. The percentage of carbon in cast iron was given in the stem of the question. Some students just described the flow chart, and gained no credit. One mark was for stating that oxygen reacted with the carbon, the other mark for stating that the percentage of carbon was reduced or that carbon dioxide was produced. Many students gained one mark for stating carbon dioxide was formed. Some students gave erroneous answers relating to the formation of alloys and not how cast iron is converted to steel.

(c) (i) This question was poorly answered. The question required the property of aluminium to be stated, namely low density. The consequence of low density being light, lightweight or lighter is true, but was not creditworthy.

(ii) There were many acceptable phrases to describe the position of copper or a transition metal in the periodic table; these were ‘central block’, ‘middle block’, ‘between Group 2 and 3’ or ‘not in a group’. Students were expected to state that aluminium is in Group 3; or ‘aluminium is in the same group as Boron’ was an acceptable alternative as to why aluminium is not a transition metal. Many students gained both marks.

(iii) Many students knew that iron is more reactive than copper. However, a significant number of students knew that there was a displacement reaction but were not sure what displaced what. Also some students used the word ‘it’ and it was difficult to know whether ‘it’ was iron or copper being displaced. Students need to clearly state which metal is displacing which metal in a displacement question. A number of students just stated that iron reacted with the salts to give copper, which was not creditworthy.