AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.2.2.7

Properties of metals and alloys

Past-paper questions

Tier	**Higher**
Question groups	**45**
Available paper years	**2007–2024**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.2.2.7 Properties of metals and alloys

Question 01

January 2007 | CHY1H | Original Q3 | Legacy

3 Many everyday items are made from iron.

(a) Haematite is an *ore* of iron. Haematite contains iron oxide, Fe_2O_3.

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

.....

.....

(1 mark)

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

What type of reaction produces the iron?

.....

.....

(1 mark)

(iii) The word equation for this reaction is:

iron oxide + carbon → iron + carbon dioxide

Complete and balance the symbol equation for this reaction.

.....Fe_2O_3 + ...C → ..... + ...

(2 marks)

Question 3 continues on the next page

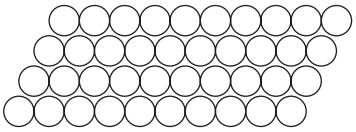
4.2.2.7 Properties of metals and alloys

Question 01 · continued

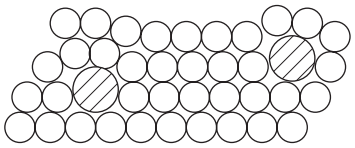
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(b) Pure iron is relatively soft and not very strong.

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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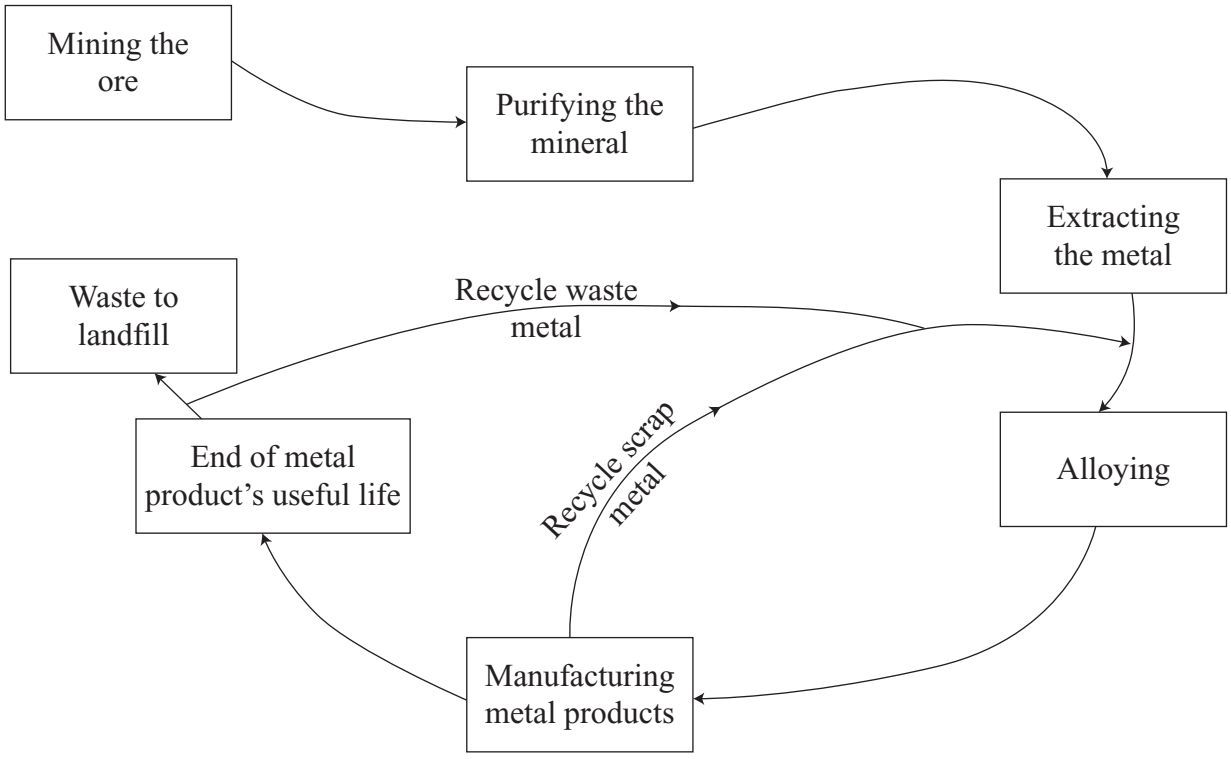
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(3 marks)

Question 01 · continued

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(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 marks)

10

4.2.2.7 Properties of metals and alloys

Question 02

March 2007 | CHY1A | Original Q5 | Legacy

QUESTION FIVE

Iron is about twice as strong as aluminium.

Some other properties of aluminium and iron are shown in the table.

	Electrical conductivity	Density in grams per cm^3	Resistance to corrosion
Aluminium	very good	2.7	good
Iron	good	7.8	poor

5A Iron is better than aluminium for making bridges.

This is because iron . . .

1 is a better insulator.

2 is more easily painted.

3 is stronger.

4 has a higher density.

5B Aluminium is better than iron for making cans for fizzy drinks.

The main reason is that . . .

1 aluminium conducts electricity better.

2 aluminium is harder.

3 iron cannot be recycled.

4 aluminium is more resistant to corrosion.

5C Aluminium has a low density and good electrical conductivity.

Which use for aluminium depends on **both** of these properties?

1 for cooking pans

2 for aeroplanes

3 for overhead power cables

4 for racing cars

4.2.2.7 Properties of metals and alloys

Question 02 · continued

5D Most of the iron that is made is converted into steel.

Compared with low carbon steel, high carbon steel . . .

1 corrodes more quickly.

2 is a better electrical conductor.

3 is harder.

4 is more easily shaped.

Turn over for the next question

4.2.2.7 Properties of metals and alloys

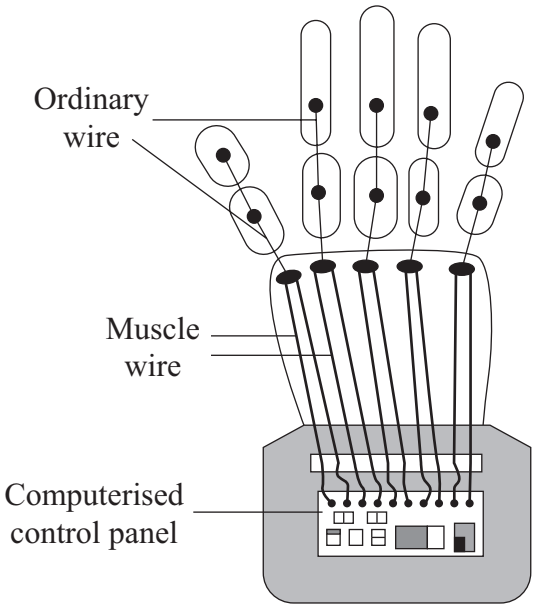
Question 03

March 2007 | CHY1A | Original Q9 | Legacy

QUESTION NINE

Muscle wire is an alloy made from nickel and titanium (Nitinol).
At room temperature, it can be stretched fairly easily.
If a small electric current is passed through the stretched wire, this causes a heating effect. As it heats up, the wire contracts back to its original length with a reasonably strong force.
If the amount of stretching is limited to less than 5 %, the alloy will go through the stretching and recovery cycle millions of times.

The diagram shows a simplified version of a robotic hand operated by muscle wire.



9A The hand will close in a gripping movement when the tension in the wires is increased by . . .

1 passing an electric current through the muscle wires.

2 putting the hand in a refrigerator.

3 there being **no** current in the muscle wire.

4 wrapping the hand in a thermal insulator, eg bubble wrap.

4.2.2.7 Properties of metals and alloys

Question 03 · continued

9B Nitinol is an alloy.

It can be described as a **smart** alloy because . . .

1 it is a flexible alloy.

2 it expands when it is heated.

3 it is made from a mixture of two metals.

4 when stretched it returns to its original length on heating.

9C A disadvantage of using smart alloys as muscle wire is that they . . .

1 are made from metals which are rare and very difficult to extract.

2 can control only a limited amount of movement.

3 cannot be permanently reshaped for a particular task.

4 corrode very easily.

9D Scientists are looking for new applications for muscle wires. All except one of the following are feasible possibilities.

Which **one** is **not** feasible?

1 making electrical wiring for houses

2 making miniature forceps that can open and close

3 making the wired braces (at low temperature) for straightening teeth

4 making bimetallic thermostats

END OF TEST

4.2.2.7 Properties of metals and alloys

Question 04

June 2007 | CHY1A | Original Q1 | Legacy

QUESTION ONE

This question is about iron and steel.

Match properties, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A hard

B resistant to corrosion

C easily shaped

D brittle

Iron from the blast furnace has few uses because it is . . . **1** . . . .

A low carbon steel is used to make wire because it is . . . **2** . . . .

A high carbon steel is used to make hammers and chisels because it is . . . **3** . . . .

A stainless steel is used to make cutlery because it is . . . **4** . . . .

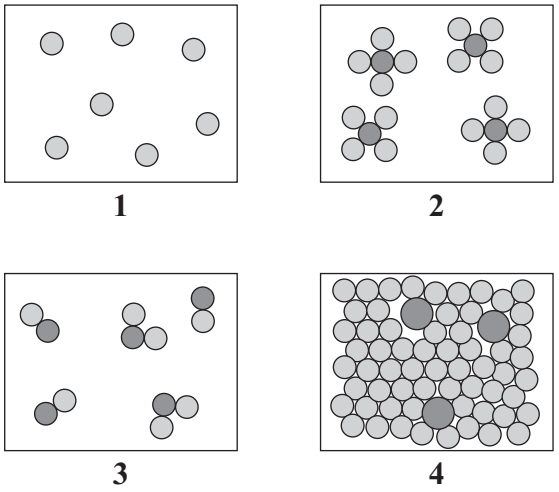
4.2.2.7 Properties of metals and alloys

Question 05

June 2007 | CHY1A | Original Q2 | Legacy

QUESTION TWO

The diagrams show the atoms in four different substances.



Match the substances, **A**, **B**, **C** and **D**, with the diagrams **1–4**.

A an alloy

B an element

C a hydrocarbon

D a mixture of compounds

4.2.2.7 Properties of metals and alloys

Question 06

June 2007 | CHY1A | Original Q5 | Legacy

QUESTION FIVE

This question is about the metals copper and zinc.

5A Copper and zinc can be extracted from their oxides by strongly heating the oxides with carbon.

In these reactions, the oxides are . . .

1 oxidised.

2 distilled.

3 reduced.

4 combined.

5B Copper can also be extracted by passing an electric current through . . .

1 solid copper oxide.

2 a solution of a copper compound.

3 a copper-rich ore.

4 impure copper.

5C There is a lot of research into new ways of extracting copper from low-grade ores.

One reason for this is . . .

1 a significant rise in the price of copper.

2 more copper ore is being found.

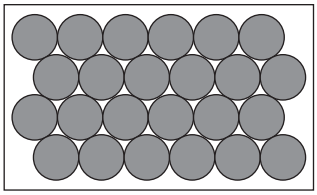
3 a reduction in the use of copper.

4 low-grade ores contain more copper.

4.2.2.7 Properties of metals and alloys

Question 06 · continued

5D The diagram shows the arrangement of the atoms in pure copper.



Pure copper is quite soft. It can be made harder by mixing it with zinc.

This is because . . .

1 the copper atoms cannot now easily slide over each other.

2 the zinc atoms attach themselves strongly to the copper atoms.

3 the zinc atoms form strong bonds with the copper atoms.

4 zinc is harder than copper.

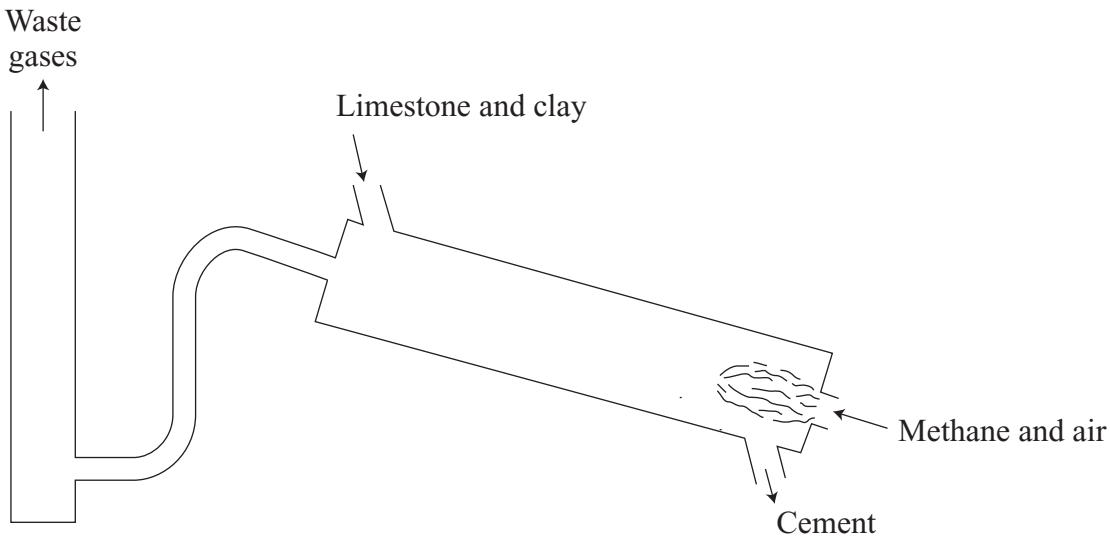
4.2.2.7 Properties of metals and alloys

Question 07

June 2007 | CHY1H | Original Q1 | Legacy

1 Limestone contains the compound calcium carbonate, $CaCO_3$.

(a) Limestone is used to make cement in a rotary kiln.



Use the information in the diagram to name the **two** main waste gases from this rotary kiln.

1 .....

2 .....

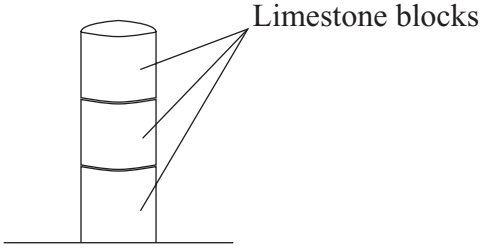
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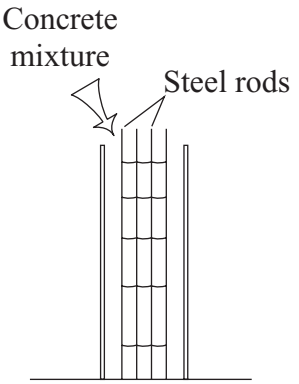
4.2.2.7 Properties of metals and alloys

Question 07 · continued

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(b) Columns used as supports for buildings can be made from materials such as limestone blocks or concrete.





Concrete is a mixture of cement, sand, small stones and water

From the diagrams, name which you think is the better material for making a column.

.....

Give **three** advantages for your choice of material.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

5

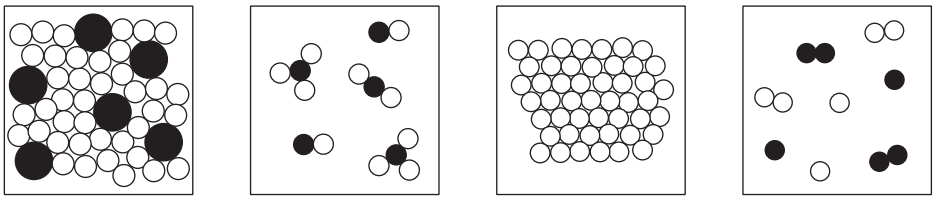
4.2.2.7 Properties of metals and alloys

Question 08

November 2007 | CHY1A | Original Q2 | Legacy

QUESTION TWO

The diagrams show the atoms in four substances.



1 **2** **3** **4**

Match words, **A**, **B**, **C** and **D**, with the diagrams **1–4**.

A pure iron

B an alloy

C a mixture of compounds

D a mixture of elements

4.2.2.7 Properties of metals and alloys

Question 09

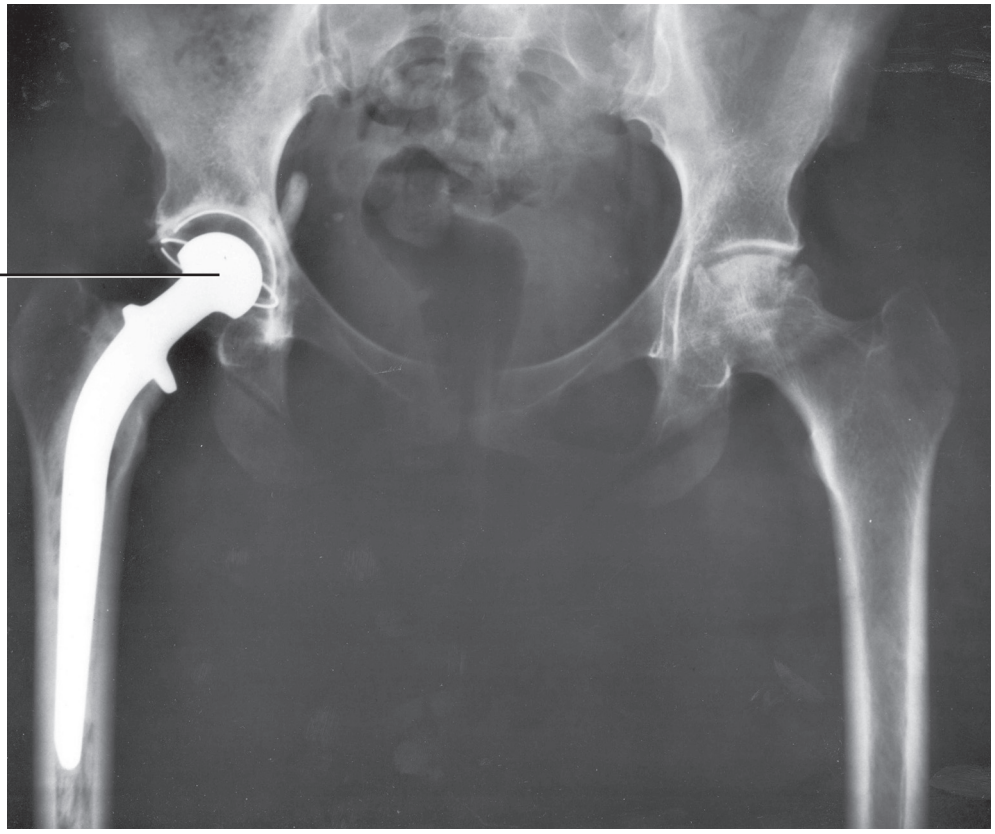
January 2008 | CHY2H | Original Q2 | Legacy

2 Read this passage about metals.

Metals are crystalline materials. The metal crystals are normally about 20 000 nm (nanometres) in diameter. The atoms inside these crystals are arranged in layers.

A new nanoscience process produces nanocrystalline metals. Nanocrystalline metals are stronger and harder than normal metals.

It is hoped that nanocrystalline metals can be used in hip replacements.



The use of nanocrystalline metals should give people better hip replacements which last longer.

(a) State why metals can be bent and hammered into different shapes.

.....

.....

(1 mark)

4.2.2.7 Properties of metals and alloys

Question 09 · continued

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(b) How is the size of the crystals in nanocrystalline metals different from the size of the crystals in normal metals?

.....

.....

(1 mark)

(c) Hip joints are constantly moving when people walk.

Suggest and explain why the hip replacement made of nanocrystalline metal should last longer than one made of normal metals.

.....

.....

.....

.....

(2 marks)

4

4.2.2.7 Properties of metals and alloys

Question 10

March 2008 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

This question is about the properties of iron and steel.

6A Production of cast iron from its ore is an example of . . .

1 oxidation.

2 reduction.

3 electrolysis.

4 combustion.

6B What is the best explanation for the softness of pure iron?

1 Iron atoms are very small so they move around easily.

2 There are bigger spaces in the metal after the impurities have been removed.

3 Pure materials are always softer than impure materials.

4 The atom layers can slide over each other quite easily.

6C To produce stainless steel from cast iron, it is necessary to . . .

1 remove the impurities.

2 remove the impurities and add other metals.

3 add other metals.

4 add extra carbon.

6D Aluminium is used in preference to iron for making cans for soft drinks.

The main reason is that . . .

1 aluminium is harder.

2 aluminium is more resistant to corrosion.

3 aluminium has a higher density.

4 aluminium is more reactive.

4.2.2.7 Properties of metals and alloys

Question 11

March 2008 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

Alloys are produced to combine the best properties of the metals used to make the alloy.

7A When aluminium is alloyed with other metals, such as copper and iron, . . .

1 it makes the alloy softer than pure aluminium.

2 it gives the alloy a greater strength than pure aluminium.

3 it makes the alloy less dense than pure aluminium.

4 it allows the alloy to corrode when it is no longer in use.

7B Which property will both the alloy and the metals it is made from **not** have?

1 good conductor of heat

2 good conductor of electricity

3 same density

4 can be hammered into shape

Shape memory alloys can 'remember' their shape and can return to it after they have been twisted into a different shape.

7C A shape memory alloy can be described as . . .

1 clever.

2 reliable.

3 sensible.

4 smart.

7D A shape memory alloy made of nickel and titanium contains 30 % titanium.

50 g of the alloy therefore contains . . .

1 30 g titanium and 20 g nickel.

2 35 g titanium and 15 g nickel.

3 25 g titanium and 25 g nickel.

4 15 g titanium and 35 g nickel.

4.2.2.7 Properties of metals and alloys

Question 12

June 2008 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

Copper is found in the Earth's crust, both as the metal itself and as a variety of compounds.

7A This suggests that copper . . .

1 is a very reactive metal.

2 reacts with only a small number of other elements.

3 is **not** very reactive but more reactive than gold.

4 reacts rapidly with oxygen and sulfur at low temperatures.

A naturally occurring compound of copper is malachite, $CuCO_3.Cu(OH)_2$

7B Which row in the table shows the number of elements and the number of atoms of oxygen in the formula for malachite?

	Elements	Atoms of oxygen
1	4	5
2	4	4
3	5	3
4	6	2

Copper is extracted from high grade ores by first smelting the mined ore, then purification by electrolysis.

Copper salts can be extracted from some low grade ores by leaching. Sulfuric acid runs through the ore to produce a solution of copper sulfate. The copper can then be obtained from the solution by electrolysis.

7C An advantage of leaching over smelting is that . . .

1 leaching produces large amounts of copper sulfate.

2 there is no chance of environmental damage during leaching.

3 leaching does **not** require large quantities of energy.

4 there are no waste products left after leaching.

4.2.2.7 Properties of metals and alloys

Question 12 · continued

7D There is plenty of scrap copper and copper alloys that could be recycled.

One factor that could bring an increase in the amount that is recycled would be . . .

1 the opening of new large mines with high grade ores.

2 a reduction in the price of copper on the world markets.

3 that recycling became much more economic than extraction from the ore.

4 other metals being used instead of copper.

Turn over for the next question

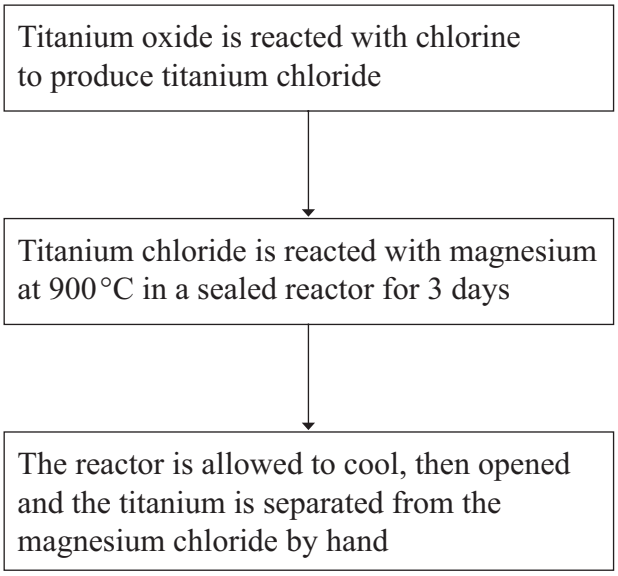
4.2.2.7 Properties of metals and alloys

Question 13

June 2008 | CHY1H | Original Q4 | Legacy

4 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.

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

.....

(1 mark)

4 (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 marks)

4.2.2.7 Properties of metals and alloys

Question 13 · continued

for mark

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

Explain why titanium costs more than steel.

.....

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.....

.....

(3 marks)

6

Turn over for the next question

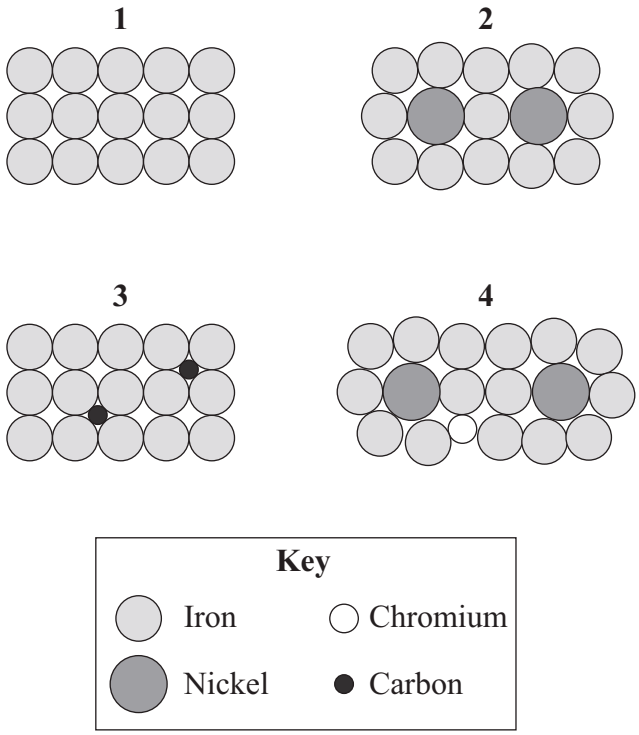
4.2.2.7 Properties of metals and alloys

Question 14

November 2008 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

The diagrams show the arrangement of atoms in a pure metal and in some alloys. The different circles represent atoms of different elements.



Match statements, **A**, **B**, **C** and **D**, with the diagrams **1–4**.

A It is a pure metal.

B It is the alloy that contains only two metals.

C It is a carbon steel alloy.

D It is the alloy that contains the largest number of different elements.

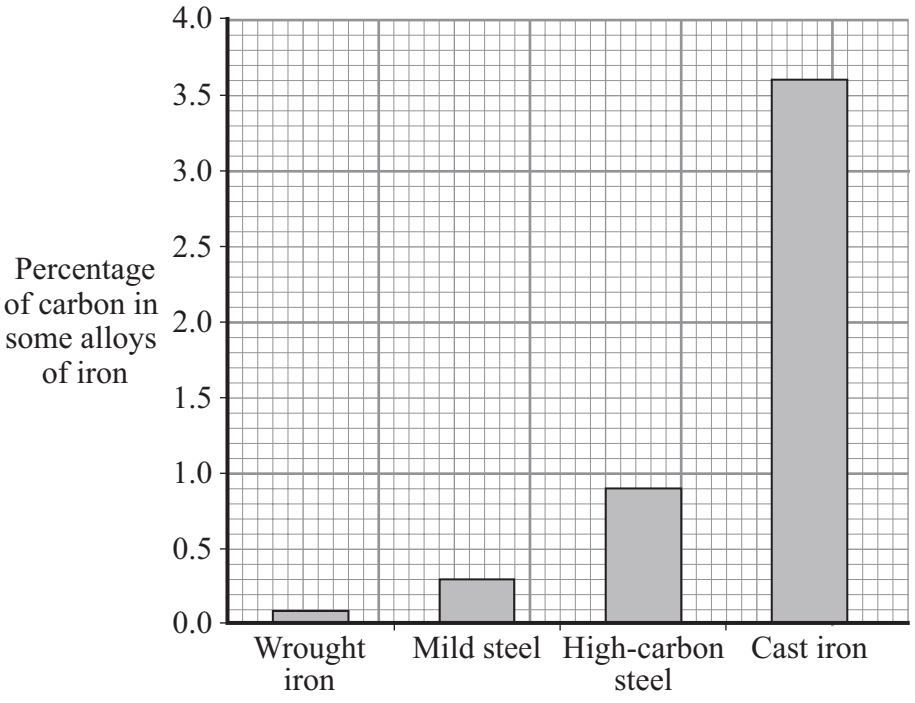
4.2.2.7 Properties of metals and alloys

Question 15

November 2008 | CHY1AP | Original Q6 | Legacy

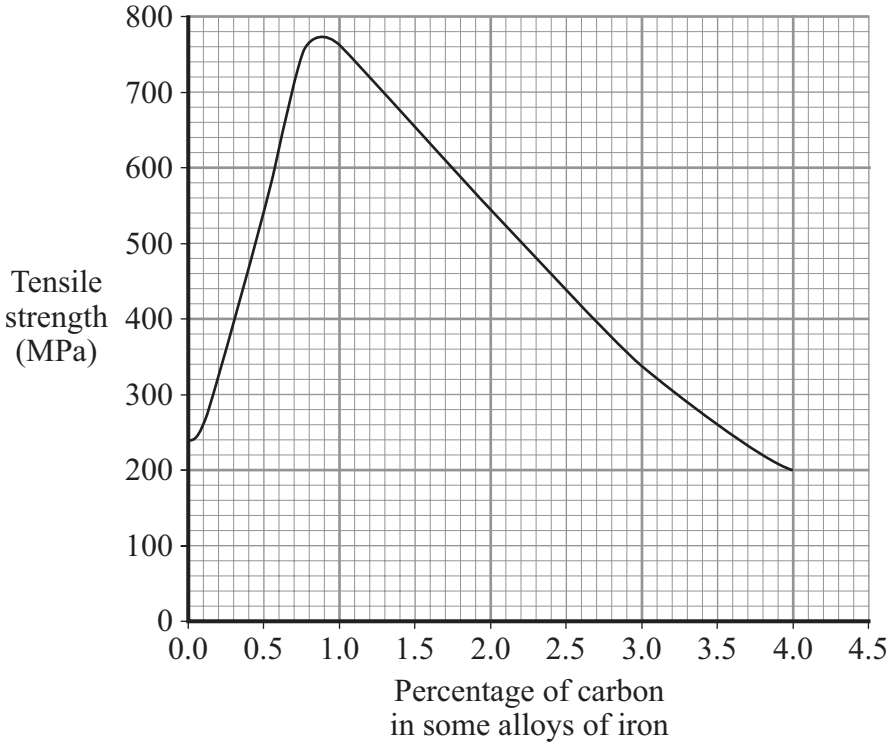
QUESTION SIX

The bar chart gives some information about the composition of some alloys of iron.



Tensile strength is a measure of the force needed to pull apart a piece of metal.

The graph shows the tensile strength of some alloys of iron.



4.2.2.7 Properties of metals and alloys

Question 15 · continued

6A Which of the following best describes how the tensile strength changes as the carbon content increases?

1 It decreases.

2 It decreases at first and then it increases.

3 It increases.

4 It increases at first and then it decreases.

6B Which alloy has the lowest tensile strength?

1 cast iron

2 high-carbon steel

3 mild steel

4 wrought iron

6C High-carbon steel is best used to make wood-cutting tools such as chisels because . . .

1 it is hard and has a high tensile strength.

2 it has a high tensile strength and is resistant to corrosion.

3 it is easily shaped and is brittle.

4 it is hard and is resistant to corrosion.

6D Pure iron . . .

1 has atoms that are arranged in distorted layers.

2 has many uses because it is hard and brittle.

3 is soft and easily shaped.

4 is used when resistance to corrosion is important.

4.2.2.7 Properties of metals and alloys

Question 16

November 2008 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

Most titanium is extracted from titanium oxide ore. The oxide is first converted to titanium chloride. The titanium chloride is then reacted with sodium as shown in the word equation.

$$\text{titanium chloride} + \text{sodium} \xrightarrow{500\,^{\circ}\text{C}} \text{titanium} + \text{sodium chloride}$$

8A Titanium metal is produced in this reaction because . . .

1 titanium is more reactive than sodium.

2 titanium chloride decomposes at 500 °C.

3 sodium is more reactive than titanium.

4 sodium chloride is a catalyst for this reaction.

8B This method of extracting titanium is expensive.

The amount of titanium that is recycled would probably be increased if . . .

1 the cost of sodium were to fall.

2 the cost of titanium were to fall.

3 new high-grade deposits of titanium oxide were discovered.

4 more uses for titanium were found.

8C Nitinol is a smart alloy made from titanium (55%) and nickel (45%).

Making 50 g of the alloy will require . . .

1 5 g of titanium and 45 g of nickel.

2 5 g of titanium and 22.5 g of nickel.

3 27.5 g of titanium and 22.5 g of nickel.

4 55 g of titanium and 45 g of nickel.

8D At room temperature (20 °C), nitinol can be stretched. If nitinol is then warmed, it contracts back to its original length.

Two possible uses of nitinol are in . . .

1 dental braces and spectacle frames.

2 dental braces and screwdrivers.

3 screwdrivers and jewellery.

4 jewellery and spectacle frames.

Turn over for the next question

4.2.2.7 Properties of metals and alloys

Question 17

March 2009 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

Solder is an alloy of lead and tin. The table shows how the percentage of tin affects some of the properties of solder.

Percentage of tin	Tensile strength in MPa	Melting point in °C	Density in g per cm^3
0	12	347	11.35
10	30	297	10.50
20	33	257	10.40
30	34	217	9.66
40	37	187	9.28
50	41	147	8.90
60	52	153	8.52
70	54	167	8.17

4A What is the density of lead in g per cm^3?

1 8.17

2 8.90

3 11.35

4 12.00

4B Increasing the percentage of tin in solder . . .

1 decreases the tensile strength of the solder.

2 decreases the density of the solder.

3 increases the flexibility of the solder.

4 increases the melting point of the solder.

4.2.2.7 Properties of metals and alloys

Question 17 · continued

4C How could the lowest melting point of solder be found accurately?

1 by using a more accurate type of thermometer

2 by repeating the measurements between 30 % and 50 % tin

3 by increasing the number of measurements between 40 % and 60 % tin

4 by increasing the number of measurements between 50 % and 70 % tin

4D How might the relationship between the percentage of tin in solder and the melting point of solder best be described?

1 The relationship is directly proportional.

2 There is no relationship.

3 As the percentage of tin increases, the melting point decreases steadily.

4 As the percentage of tin increases, the melting point decreases, and then starts to rise.

4.2.2.7 Properties of metals and alloys

Question 18

June 2009 | CHY1H | Original Q4 | Legacy

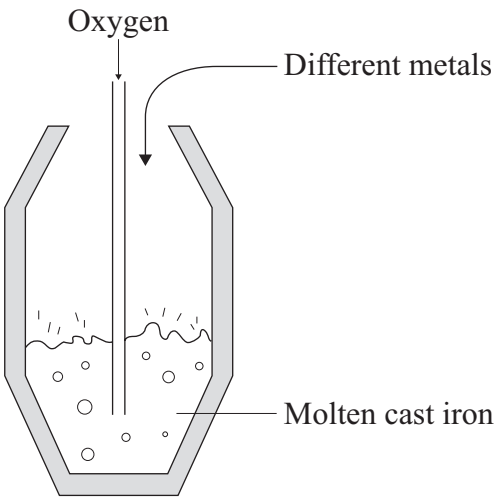
4 The demand for iron and steel is high.

4 (a) Iron that is extracted from its oxide by carbon reduction in a blast furnace is called cast iron. Cast iron contains about 4% carbon. This carbon makes cast iron very brittle.

Carbon steels can be made by the following processes.

- Blowing oxygen into molten cast iron to remove most of the carbon.
- Adding a calculated amount of carbon.

Sometimes different metals may also be added to the molten carbon steels.



4 (a) (i) Suggest how blowing oxygen into molten cast iron removes most of the carbon.

.....

.....

.....

.....

(2 marks)

4 (a) (ii) Why are different metals sometimes added to molten carbon steels?

.....

.....

(1 mark)

4.2.2.7 Properties of metals and alloys

Question 18 · continued

for mark

4 (b) The percentage of iron and steel recycled in the UK has been increasing.

Year	% iron and steel recycled
1998	25
2000	35
2002	42
2004	46
2006	57

The UK government has set targets for the percentage of iron and steel to be recycled. In 2006 the target was exceeded.

Suggest **two** reasons why the UK government wants to encourage recycling of iron and steel.

1 .....

.....

2 .....

.....

(2 marks)

5

4.2.2.7 Properties of metals and alloys

Question 19

November 2009 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

Duralumin is an alloy which contains copper and magnesium mixed with aluminium.

Aluminium is a low density metal but duralumin is used more often in making aeroplanes.

4A Aluminium, copper and magnesium are extracted from their naturally occurring compounds.

The method used for the extraction depends on . . .

1 the density of the metal.

2 the abundance of the metal compound in the Earth's crust.

3 the melting point of the metal compound.

4 the reactivity of the metal.

4B Copper can be extracted by strongly heating a mixture of the copper compound and carbon.

In this reaction, the copper compound is . . .

1 oxidised.

2 electrolysed.

3 reduced.

4 distilled.

4C Aluminium and magnesium are extracted by electrolysis.

One reason why this method is expensive is that . . .

1 the metals are resistant to corrosion.

2 the process requires a large amount of energy.

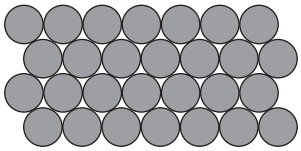
3 the metals are less reactive than carbon.

4 the metal ores are very abundant.

4.2.2.7 Properties of metals and alloys

Question 19 · continued

4D The diagram shows the arrangement of the atoms in pure aluminium.



Which row in the table correctly shows how the structure and properties are different in duralumin?

	Structure	Properties
1	The layers of atoms are distorted.	The alloy is harder.
2	The copper atoms attach strongly to the aluminium atoms.	The alloy is softer.
3	The layers of atoms are distorted.	The alloy is softer.
4	The magnesium atoms attach strongly to the aluminium atoms.	The alloy is harder.

4.2.2.7 Properties of metals and alloys

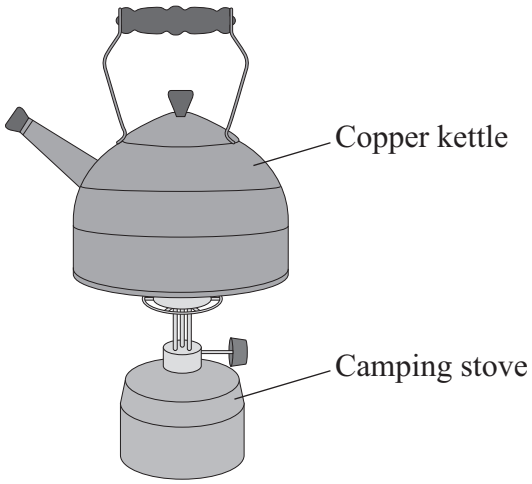
Question 20

January 2010 | CHY2H | Original Q4 | Legacy

4 The picture shows a copper kettle being heated on a camping stove.

Copper is a good material for making a kettle because:

- it has a high melting point
- it is a very good conductor of heat.



4 (a) Explain why copper, like many other metals, has a high melting point.
You should describe the structure and bonding of a metal in your answer.

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(4 marks)

4.2.2.7 Properties of metals and alloys

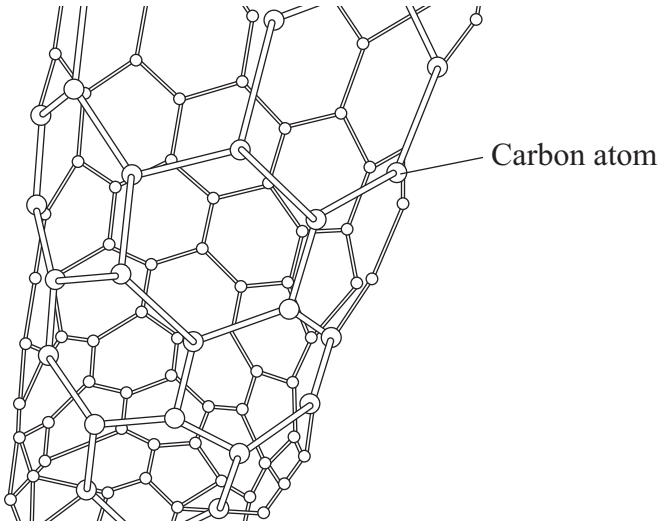
Question 20 · continued

for mark

4 (b) An aeroplane contains many miles of electrical wiring made from copper. This adds to the mass of the aeroplane.

It has been suggested that the electrical wiring made from copper could be replaced by lighter carbon nanotubes.

The diagram shows the structure of a carbon nanotube.



4 (b) (i) What does the term 'nano' tell you about the carbon nanotubes?

.....

.....

(1 mark)

4 (b) (ii) Like graphite, each carbon atom is joined to three other carbon atoms.

Explain why the carbon nanotube can conduct electricity.

.....

.....

.....

.....

(2 marks)

7

4.2.2.7 Properties of metals and alloys

Question 21

March 2010 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about types of reactions.

Match type of reaction, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A reduction

B combustion

C thermal decomposition

D corrosion

	Example of the type of reaction
1	Copper carbonate forms copper oxide and carbon dioxide when heated.
2	Hydrogen reacts with oxygen to produce water.
3	Carbon steels react when exposed to air and water.
4	Zinc is obtained from zinc oxide by removal of the oxygen.

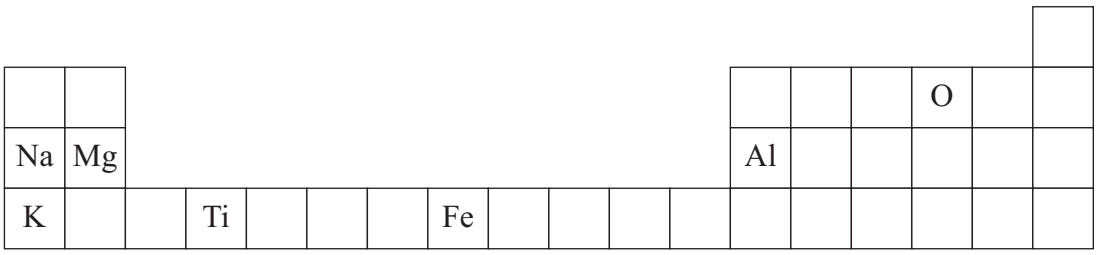
4.2.2.7 Properties of metals and alloys

Question 22

March 2010 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

This is part of the periodic table.



3A What do the metals Fe (iron) and Ti (titanium) have in common?

1 They belong to the same group in the periodic table.

2 They are transition metals.

3 They do **not** conduct electricity.

4 They are resistant to corrosion.

3B When Fe (iron) and O (oxygen) react, iron atoms join with oxygen atoms to form iron oxide, Fe_2O_3

When this happens, . . .

1 the nuclei from iron and oxygen atoms join together.

2 electrons are lost and new atoms form.

3 electrons are transferred and chemical bonds hold the atoms together.

4 the nuclei are transferred and new atoms form.

Question 22 · continued

3C Fe (iron) and O (oxygen) are in the periodic table but Fe_2O_3 (iron oxide) is not.

This is because iron oxide is . . .

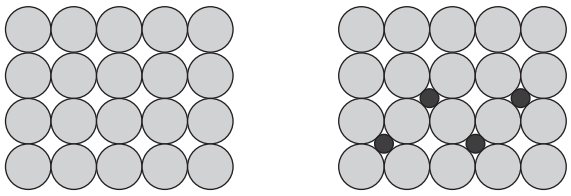
1 an alloy.

2 a compound.

3 an ore.

4 a gas.

3D The diagram shows the arrangement of atoms in pure iron and in steel.



Pure iron **Steel**

Which row in the table shows the metal that is harder **and** correctly explains why it is harder?

	Harder metal	Explanation
1	Pure iron	It contains only one type of atom.
2	Steel	The atoms cannot easily slide over each other.
3	Pure iron	The atoms cannot easily slide over each other.
4	Steel	It contains only one type of atom.

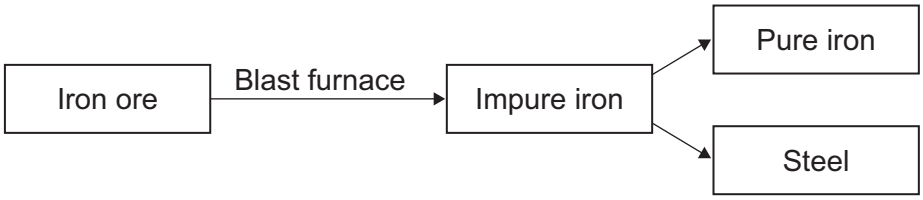
4.2.2.7 Properties of metals and alloys

Question 23

June 2010 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

The flow chart shows how iron ore can be changed into useful materials.



3A Iron ore is the starting material for making iron because . . .

1 iron ore is magnetic.

2 iron ore contains a reasonable amount of iron oxide.

3 a lot of energy is needed to convert iron ore into iron.

4 mining iron ore does not cause any environmental problems.

3B In the blast furnace, iron oxide is converted to iron using carbon. This is because . . .

1 iron is less reactive than carbon.

2 iron is more reactive than carbon.

3 carbon is a cheap material to use.

4 carbon combines with the metal impurities in the iron ore, leaving iron.

4.2.2.7 Properties of metals and alloys

Question 23 · continued

3C Impure iron is hard and brittle. This is because in impure iron . . .

1 the impurities distort the layers of atoms so they cannot slide over each other.

2 the carbon breaks up the iron structure, allowing it to bend easily.

3 its structure has been destroyed by heating to a very high temperature.

4 all the atoms are the same and so remain in a regular arrangement.

3D When impure iron is converted into steel, . . .

1 all the carbon is removed and not replaced.

2 the amount of carbon is carefully controlled.

3 all the metal impurities are removed and not replaced.

4 chromium is always added to the iron.

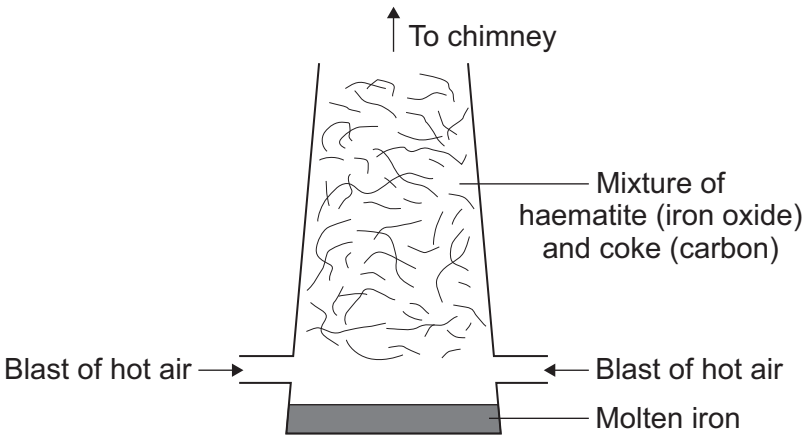
Turn over for the next question

4.2.2.7 Properties of metals and alloys

Question 24

June 2010 | CHY1H | Original Q3 | Legacy

3 Iron is produced by reacting a mixture of haematite and coke in a blast furnace.
Haematite is an ore of iron containing iron oxide (Fe_2O_3).
Coke is made from coal and is almost pure carbon.



3 (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.

..... + O_2 → CO_2

(1 mark)

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

iron oxide + carbon monoxide → iron + carbon dioxide

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

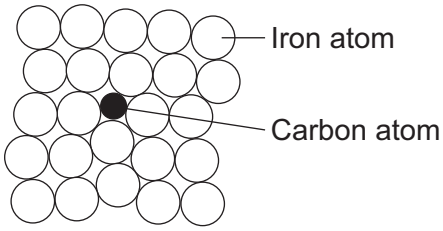
Fe_2O_3 + 3CO → ..... + ...

(2 marks)

4.2.2.7 Properties of metals and alloys

Question 24 · continued

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



Why is pure iron softer than cast iron?

.....

.....

.....

(1 mark)

3 (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 .....

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3 .....

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(3 marks)

7

4.2.2.7 Properties of metals and alloys

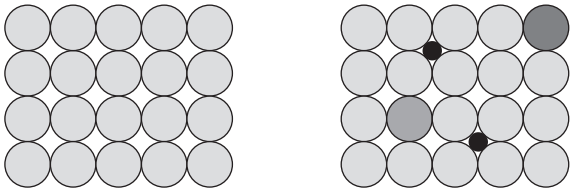
Question 25

June 2011 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

This question is about iron and different types of steel.

3A The diagrams show the arrangement of atoms in pure iron and in stainless steel.



Pure iron Stainless steel

Pure iron is soft and easily shaped because the atoms . . .

1 are not arranged in a regular pattern.

2 are small and spherical.

3 are in layers that can slide over each other.

4 are of different sizes.

3B Stainless steel rather than pure iron is used for making cutlery.

Which row in the table gives two reasons why stainless steel is used?

Stainless steel . . .		
1	is harder.	is a better heat conductor.
2	is more resistant to corrosion.	is harder.
3	is a better heat conductor.	can be more easily shaped.
4	can be more easily shaped.	is more resistant to corrosion.

4.2.2.7 Properties of metals and alloys

Question 25 · continued

3C Which type of iron or steel is used to make hammer heads and chisels?

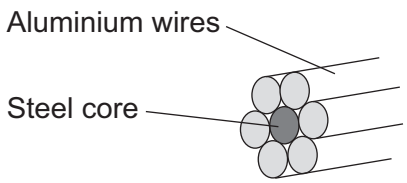
1 cast iron (iron from a blast furnace)

2 pure iron

3 low carbon steel

4 high carbon steel

3D The diagram shows the structure of an overhead power cable. The steel core gives strength to the cable.



Aluminium is used because it is a good conductor of electricity and . . .

1 it has a low density.

2 it is a good conductor of heat.

3 it can be hammered into shape.

4 it is a hard metal.

4.2.2.7 Properties of metals and alloys

Question 26

June 2011 | CHY1AP | Original Q9 | Legacy

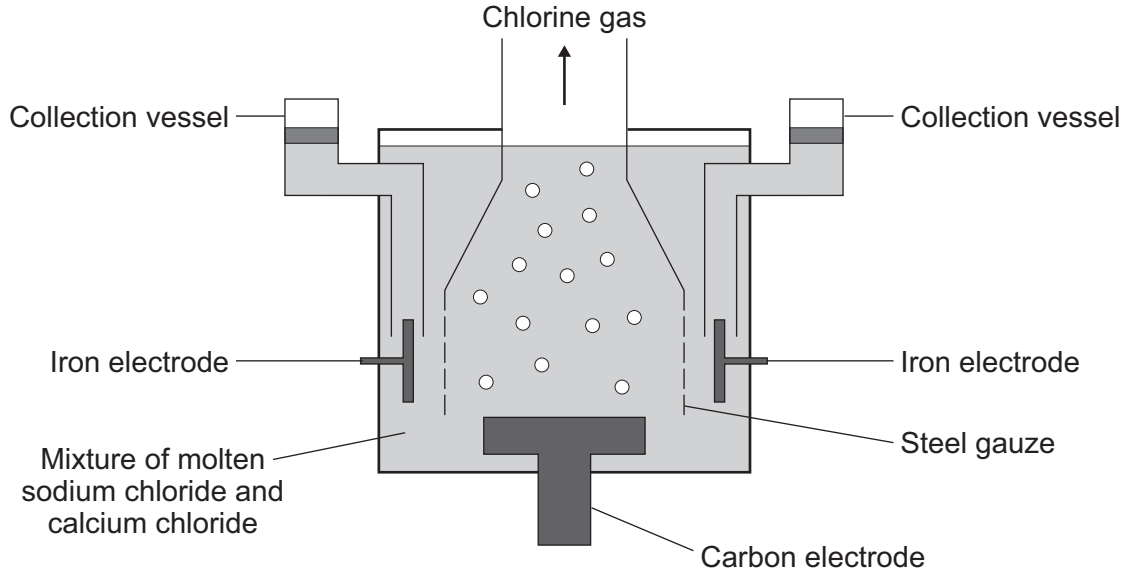
QUESTION NINE

Sodium cannot be extracted from its oxide by reduction with carbon.

Sodium metal is extracted by electrolysis of molten sodium chloride. The melting point of sodium chloride is very high (800°C), so calcium chloride is added to reduce the melting point of the mixture to about 550°C.

During electrolysis, both sodium and calcium are obtained at the iron electrodes, and chlorine at the carbon electrode.

The diagram shows the electrolysis cell used for the extraction of sodium.



The table shows some properties of sodium and calcium.

	Melting point in °C	Density in g per cm^3	Reactivity
Sodium	97	0.97	Very reactive
Calcium	839	1.55	Reactive

9A In the extraction of sodium, a mixture of sodium chloride and calcium chloride is used to . . .

1 reduce the amount of energy required to melt the mixture.

2 obtain a pure sample of sodium.

3 absorb the chlorine gas.

4 increase the temperature of the mixture.

Question 26 · continued

9B The purpose of the steel gauze is to prevent the reaction of . . .

1 sodium with calcium.

2 sodium with chlorine.

3 iron electrodes with sodium chloride.

4 sodium chloride with calcium chloride.

9C In the collection vessel there is . . .

1 solid sodium below a layer of liquid calcium.

2 solid calcium below a layer of liquid sodium.

3 a mixture of liquid sodium and liquid calcium.

4 a mixture of solid calcium and solid sodium.

9D The information in the diagram suggests that the element carbon . . .

1 has a melting point lower than 550 °C.

2 reacts rapidly with chlorine gas.

3 is an electrical conductor.

4 is more reactive than iron.

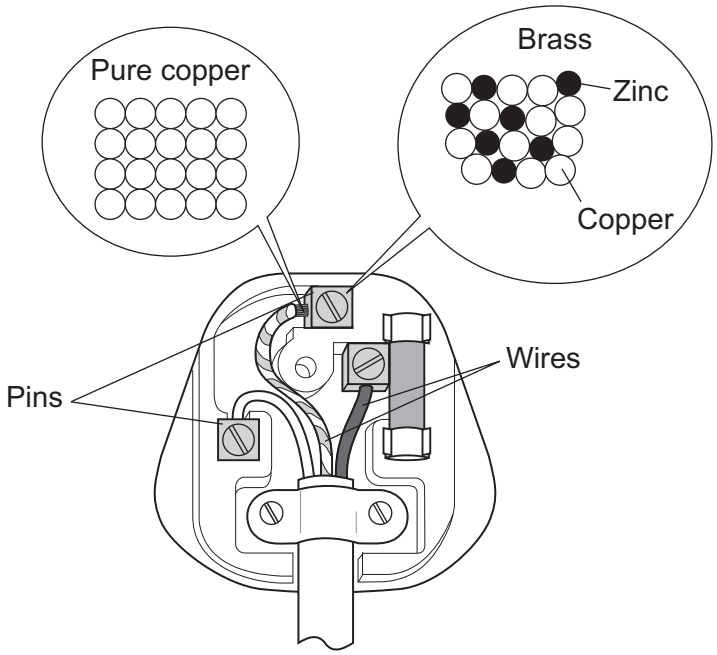
END OF TEST

4.2.2.7 Properties of metals and alloys

Question 27

June 2011 | CHY1H | Original Q3 | Legacy

3 The diagram shows an electric plug.



3 (a) Brass is used for the pins because it is harder than pure copper. Use the particle diagrams to help you to explain why.

.....

.....

.....

.....

(2 marks)

Question 3 continues on the next page

4.2.2.7 Properties of metals and alloys

Question 27 · continued

3 (b) An ore contains a mixture of zinc carbonate and lead carbonate. Zinc and lead are produced from this ore by two reactions.

3 (b) (i) **Reaction 1**: The carbonates in the ore are converted into a mixture of zinc oxide and lead oxide.

Name this type of reaction. .....

How is this reaction done? .....

.....

(2 marks)

3 (b) (ii) **Reaction 2**: The metal oxides are mixed with carbon and heated in a furnace to produce zinc and lead.

Explain why zinc and lead are produced.

.....

.....

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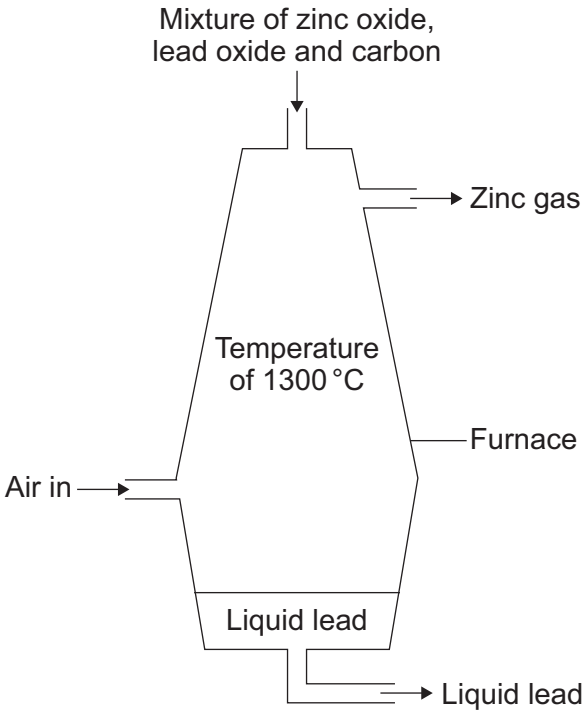
.....

(2 marks)

4.2.2.7 Properties of metals and alloys

Question 27 · continued

3 (b) (iii) The diagram represents a furnace used to produce zinc and lead from their oxides.



Metal	Melting point in °C	Boiling point in °C	Density in g per cm^3
Lead	328	1751	11.3
Zinc	420	908	7.1

Use the diagram and the information in the table to explain how zinc and lead are separated in the furnace.

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(2 marks)

8

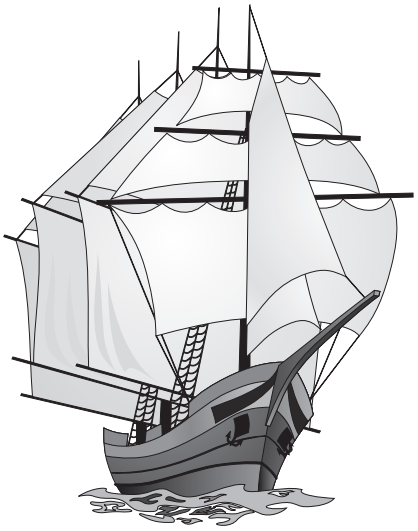
4.2.2.7 Properties of metals and alloys

Question 28

June 2011 | CHY3H | Original Q2 | Legacy

2 Read the information about protecting the bottoms of ships.

A Copper-bottomed Investment



From the 16th to the 19th century, the bottoms of many wooden ships were protected from marine organisms by being covered with sheets of metal.

At first lead was used on the bottoms of ships, then copper was used until 1832 when Muntz Metal replaced it. Muntz Metal is an alloy of two transition metals, copper and zinc.

Table of data

	Lead	Copper	Muntz Metal
Cost (£/kg)	£1.20	£3.20	£2.30
Melting point (°C)	327	1083	904
Stops sea worms attacking wood	Yes	Yes	Yes
Stops barnacles and seaweed sticking to the bottom of the ship	No	Yes	Yes

4.2.2.7 Properties of metals and alloys

Question 28 · continued

2 (a) Use the information to answer the following questions.

2 (a) (i) Suggest why copper replaced lead.

.....

.....

(1 mark)

2 (a) (ii) Suggest why Muntz Metal replaced copper.

.....

.....

(1 mark)

2 (b) A sample of Muntz Metal contains a very small amount of iron as an impurity.

2 (b) (i) Name an instrumental method of analysis that could be used to detect iron.

.....

(1 mark)

2 (b) (ii) Suggest why an instrumental method would detect the iron in this sample of Muntz Metal but a chemical method is **not** likely to be successful.

.....

.....

(1 mark)

2 (c) Today, ships are made from steel. Steels are alloys of iron, a transition metal.

Give **two** properties of transition metals that make them suitable for making ships.

Property 1 .....

.....

Property 2 .....

.....

(2 marks)

6

4.2.2.7 Properties of metals and alloys

Question 29

November 2011 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

Titanium (Ti) is extracted from the ore called rutile. Rutile is mainly made up of titanium oxide (TiO_2). Titanium is not very reactive so it should be possible to displace titanium from its oxide with carbon. But carbon reacts with titanium, making it very brittle.

Therefore, titanium is extracted by reacting titanium chloride ($TiCl_4$) with sodium. Titanium chloride is produced by reacting titanium oxide with chlorine. The sodium used for the reaction is obtained by electrolysis.

The titanium chloride is added to a reactor in which sodium has been heated to about 550 °C in an inert argon atmosphere. During the reaction, the temperature increases to about 1000 °C.
After the reaction is complete, and everything has cooled, which can take several days, the mixture is crushed and washed with water to remove the sodium chloride (NaCl).

7A Which row in the table is the correct order of reactivity for carbon, sodium and titanium?

	Most reactive ⟶		**Least reactive**
1	sodium	carbon	titanium
2	carbon	titanium	sodium
3	titanium	carbon	sodium
4	sodium	titanium	carbon

7B The equation for the reaction of titanium chloride with sodium is shown below.

$$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$$

When 190 g of titanium chloride were reacted with sodium, 48 g of titanium and 234 g of sodium chloride were produced.

How much sodium is required to produce 48 g of titanium?

1 23 g

2 92 g

3 190 g

4 234 g

Question 29 · continued

7C A student suggested that there are four possible reasons why titanium is expensive.

J the cost of the process used to remove the sodium chloride
K large amounts of energy are needed to produce the sodium
L it takes several days to complete the process of separating the mixture
M the reacting mixture needs to be cooled to a low temperature

Which two of these reasons are correct?

1 **J** and **M**

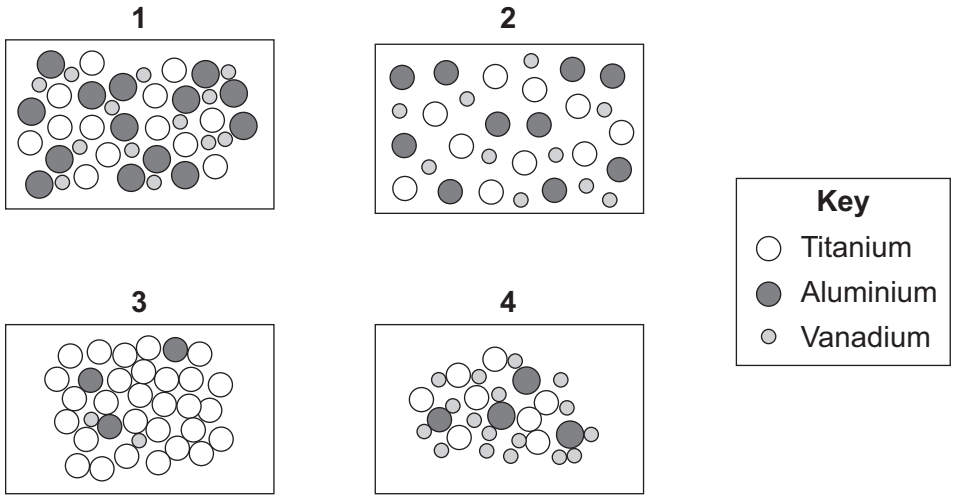
2 **K** and **L**

3 **J** and **K**

4 **L** and **M**

7D Titanium is often alloyed with small amounts of vanadium (4 %) and aluminium (6 %). This makes the titanium harder and stronger.

Which of the diagrams below shows the atoms in a sample of this titanium alloy?



4.2.2.7 Properties of metals and alloys

Question 30

January 2012 | CH1HP | Original Q4 | Legacy

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



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

4 (a) (i) Name this type of reaction.

.....

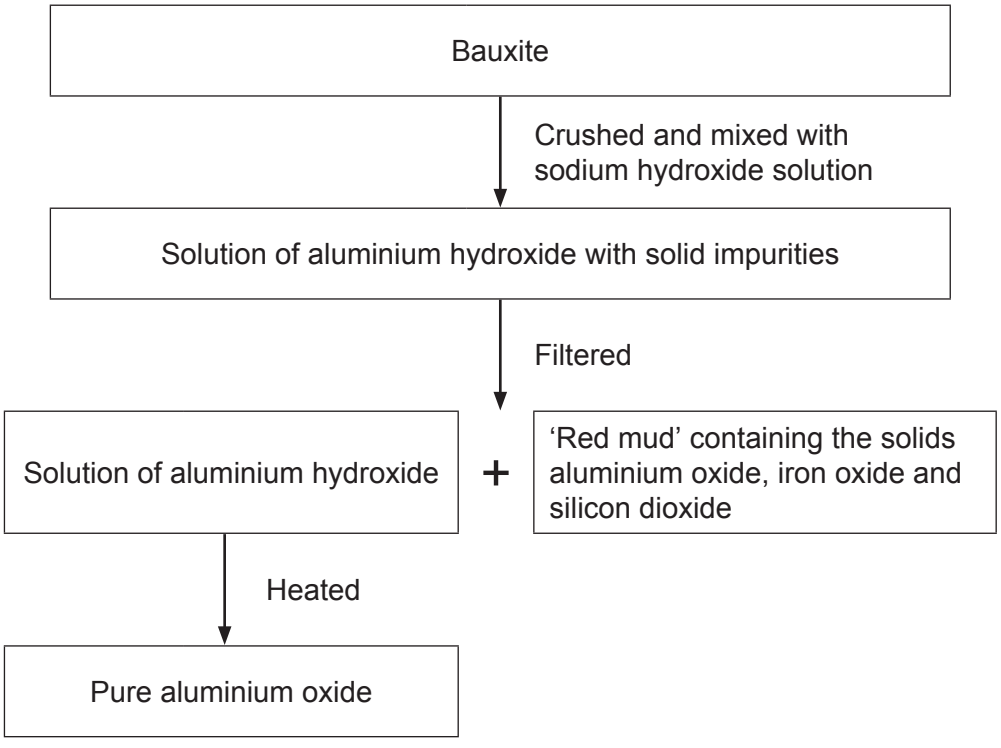
(1 mark)

4 (a) (ii) Balance the symbol equation for this reaction.

$2Fe_2O_3$ + ... C → ..... Fe + ... CO_2

(1 mark)

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



4.2.2.7 Properties of metals and alloys

Question 30 · continued

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

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

4 (b) (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 mark)

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

.....

(1 mark)

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

Suggest **one** reason why.

.....

(1 mark)

4 (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 .....

.....

(2 marks)

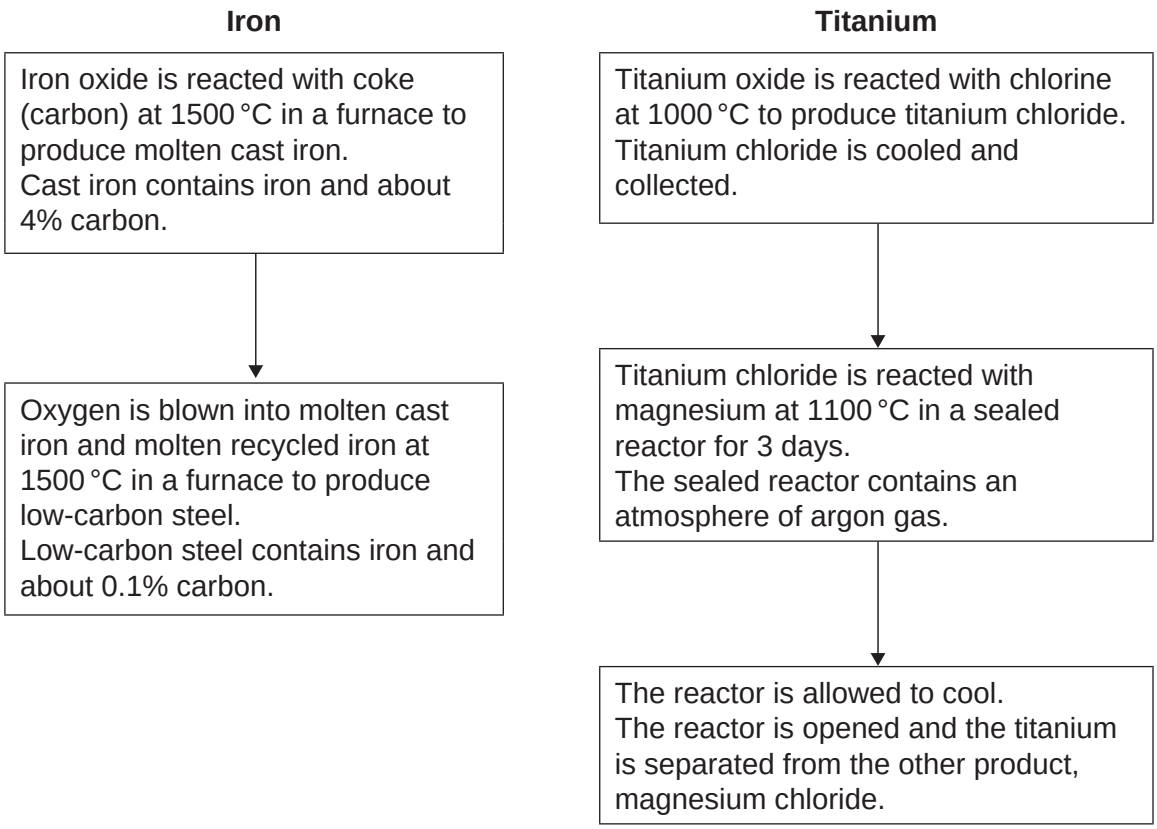
7

4.2.2.7 Properties of metals and alloys

Question 31

7 Iron is produced from the ore haematite (iron oxide).

Titanium is produced from the ore rutile (titanium oxide).



7 (a) The production of low-carbon steel uses oxygen but the production of titanium uses argon.

Explain why.

.....

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(3 marks)

4.2.2.7 Properties of metals and alloys

Question 31 · continued

7 (b) There is less titanium than iron in the Earth's crust.

Apart from titanium's scarcity, explain why titanium costs much more than iron.

Use the two flow diagrams on page 16 to help you to answer this question.

.....

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(3 marks)

7 (c) Many chemical reactions take place in the production of both metals.

A chemical reaction in the production of iron is:

$$2\,Fe_2O_3 + 3\,C \rightarrow 4\,Fe + 3\,CO_2$$

A chemical reaction in the production of titanium is:

$$TiCl_4 + 2\,Mg \rightarrow Ti + 2\,MgCl_2$$

Titanium can be used to produce iron from iron oxide. The chemical reaction is:

$$2\,Fe_2O_3 + 3\,Ti \rightarrow 4\,Fe + 3\,TiO_2$$

Use these three reactions and the Chemistry Data Sheet to answer this question.

Suggest the position of titanium in the Reactivity Series of Metals.

Explain your answer.

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(2 marks)

8

4.2.2.7 Properties of metals and alloys

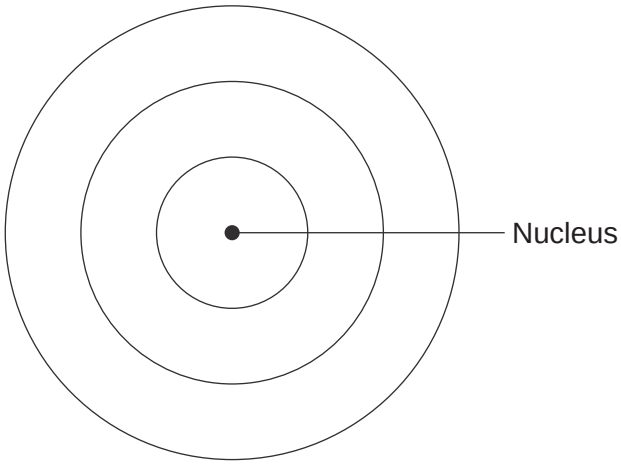
Question 32

June 2013 | CH1HP | Original Q1 | Legacy

1 Aluminium has many uses.

1 (a) An aluminium atom has 13 electrons.

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



(1 mark)

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

..... and .....

(1 mark)

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

.....

.....

(1 mark)

4.2.2.7 Properties of metals and alloys

Question 32 · continued

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.

1 (b) (i) Balance the chemical equation for the reaction.

.....Al + Fe_2O_3 ⟶ .....Fe + Al_2O_3

(1 mark)

1 (b) (ii) Why does aluminium react with iron oxide?

.....

.....

(1 mark)

5

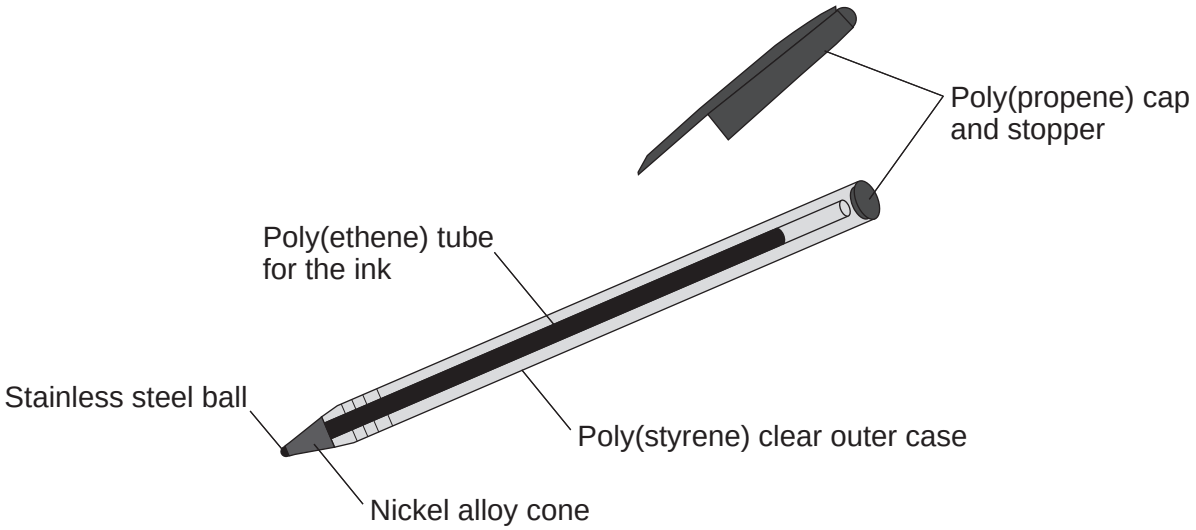
Turn over for the next question

4.2.2.7 Properties of metals and alloys

Question 33

June 2013 | CH1HP | Original Q4 | Legacy

4 The diagram shows a ballpoint pen.



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

.....

.....

.....

.....

(2 marks)

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

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

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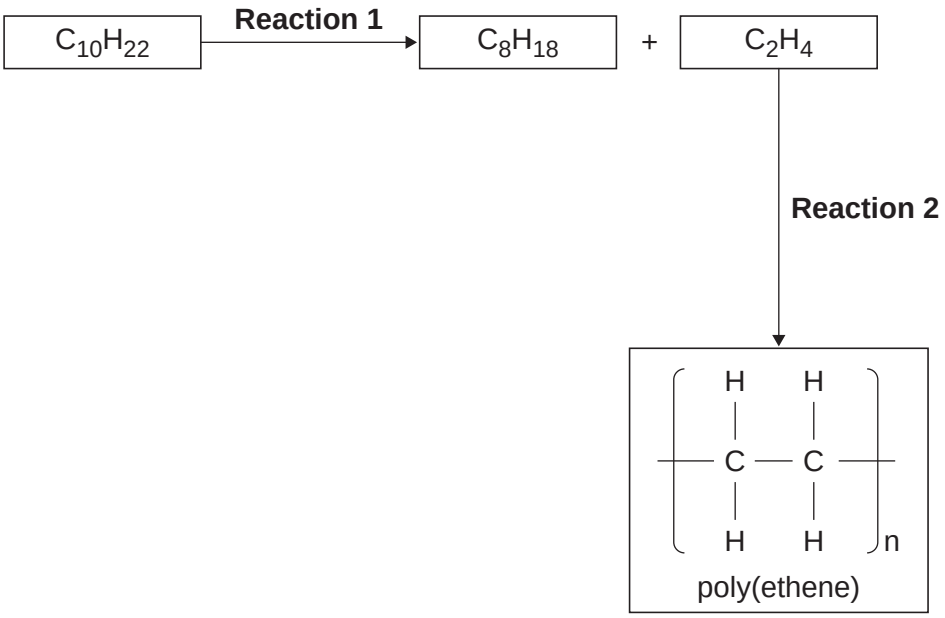
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(2 marks)

4.2.2.7 Properties of metals and alloys

Question 33 · continued

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



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

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(2 marks)

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

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(2 marks)

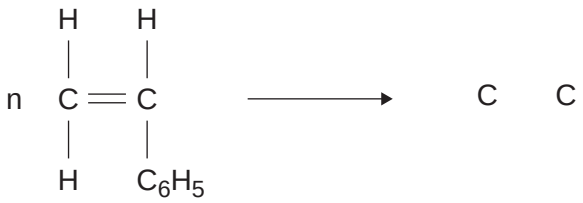
Question 4 continues on the next page

4.2.2.7 Properties of metals and alloys

Question 33 · continued

June 2013 | CH1HP | Original Q4 | Legacy

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



styrene poly(styrene)

(2 marks)

10

Question 34

June 2013 | CH2HP | Original Q5 | Legacy

5 Oil rigs are used to drill for crude oil.



5 (a) Drill heads are made from steel. Steel is an alloy.

Explain why alloys are harder than pure metals.

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(3 marks)

4.2.2.7 Properties of metals and alloys

Question 34 · continued

5 (b) Drill heads also contain diamonds.

Describe, as fully as you can, the structure and bonding in diamond.

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(4 marks)

5 (c) Polymers are produced from crude oil.

Describe the structure and bonding in a thermosoftening polymer and explain why thermosoftening polymers melt when heated.

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(4 marks)

11

4.2.2.7 Properties of metals and alloys

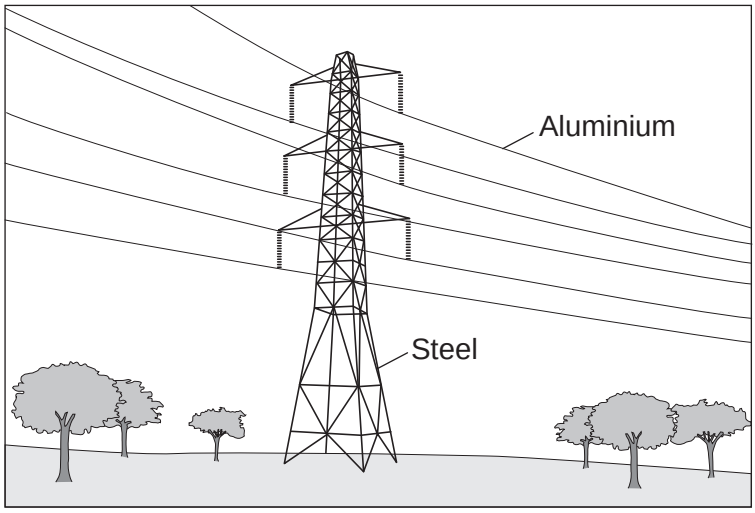
Question 35

June 2015 | CH1HP | Original Q4 | Legacy

4 This question is about metals.

Figure 4 shows the metals used to make pylons and the wires of overhead cables.

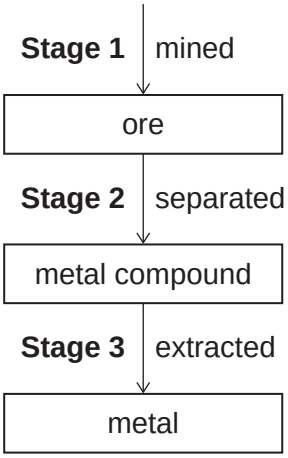
Figure 4



4 (a) An ore contains a metal compound.

A metal is extracted from its ore in three main stages, as shown in **Figure 5**.

Figure 5



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

[2 marks]

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4.2.2.7 Properties of metals and alloys

Question 35 · continued

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

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

Give **one** reason why.

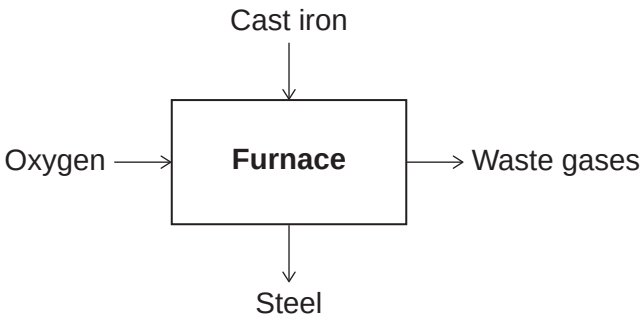
[1 mark]

.....

.....

4 (b) (ii) Most cast iron is converted into steel, as shown in **Figure 6**.

Figure 6



Describe how cast iron is converted into steel.

Use **Figure 6** to help you to answer this question.

[2 marks]

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.....

Question 4 continues on the next page

4.2.2.7 Properties of metals and alloys

Question 35 · continued

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

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

[1 mark]

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.....

4 (c) (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 marks]

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

Explain why.

[2 marks]

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10

4.2.2.7 Properties of metals and alloys

Question 36

June 2015 | CH2HP | Original Q3 | Legacy

3 This question is about metals and alloys.

3 (a) Explain how electricity is conducted in a metal.

To gain full marks you must include a description of the structure and bonding of a metal.

[4 marks]

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3 (b) Describe how the structure of an alloy is different from the structure of a pure metal.

[2 marks]

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3 (c) Alloys are used to make dental braces and coins.

3 (c) (i) Nitinol is an alloy used in dental braces.

Why is Nitinol used in dental braces?

[1 mark]

.....

.....

4.2.2.7 Properties of metals and alloys

Question 36 · continued

3 (c) (ii) Suggest **one** reason why coins are not made of pure copper.

Do **not** give cost as a reason.

[1 mark]

.....

.....

3 (c) (iii) Some coins are made from an alloy of aluminium.

Complete the sentence.

[1 mark]

Aluminium is manufactured by the electrolysis of a molten mixture of

cryolite and ..... .

3 (c) (iv) Banks keep coins in poly(ethene) bags. These bags are made from low density poly(ethene).

High density poly(ethene) can also be made from the same monomer.

How can the same reaction produce two different products?

[1 mark]

.....

.....

3 (d) Give **two** reasons why instrumental methods of analysis are used to detect impurities in metals.

[1 mark]

.....

.....

.....

11

4.2.2.7 Properties of metals and alloys

Question 37

June 2016 | CH1HP | Original Q3 | Legacy

3 Metals are extracted from ores in the Earth's crust.

Some ores contain metal carbonates and some ores contain metal oxides.

3 (a) (i) Name the type of reaction that happens when a metal carbonate is heated.

[1 mark]

_____

3 (a) (ii) Which solid product is formed when copper carbonate is heated?

[1 mark]

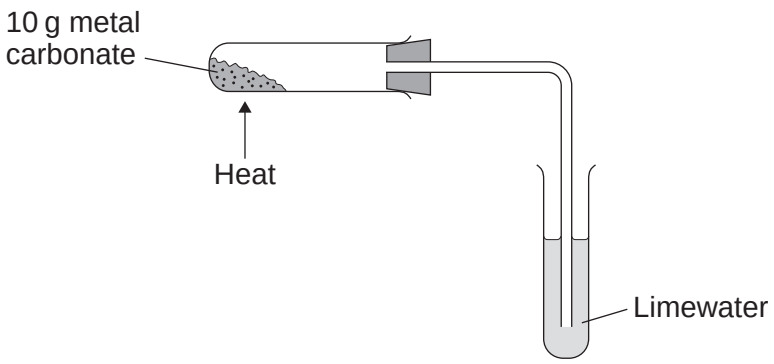
Tick (✓) **one** box.

- copper ☐
- copper nitrate ☐
- copper oxide ☐
- copper sulfide ☐

3 (b) A student investigated heating four metal carbonates.

Figure 4 shows the apparatus used.

Figure 4



4.2.2.7 Properties of metals and alloys

Question 37 · continued

The student heated each metal carbonate for five minutes.

Table 3 shows the results.

Table 3

Metal carbonate	Mass of metal carbonate at start in g	Mass of solid after heating for 5 minutes in g	Observations
Copper carbonate	10.0	6.9	Limewater turns cloudy
Magnesium carbonate	10.0	9.1	Limewater turns cloudy
Potassium carbonate	10.0	10.0	Limewater does not turn cloudy
Zinc carbonate	10.0	8.3	Limewater turns cloudy

3 (b) (i) Explain the results for potassium carbonate.

[3 marks]

3 (b) (ii) Suggest how the reactivity series can be used to predict which metal carbonate reacts most easily when heated.

[2 marks]

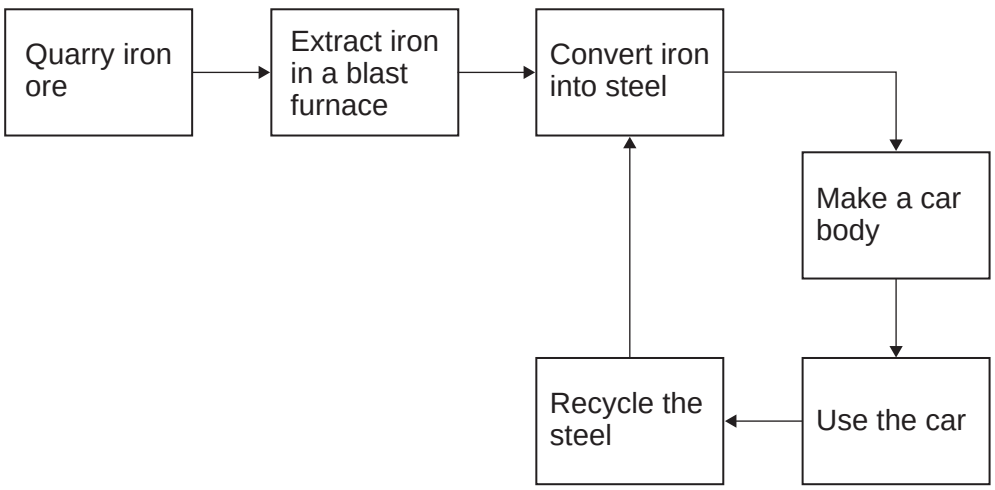
Question 3 continues on the next page

4.2.2.7 Properties of metals and alloys

Question 37 · continued

3 (c) **Figure 5** shows a simple life cycle of a car body.

Figure 5



3 (c) (i) Complete the sentence.

[1 mark]

Iron ores must contain enough iron to _____

_____

3 (c) (ii) Some iron ores contain iron oxide (Fe_2O_3).

Complete and balance the equation for a reaction to produce iron from iron oxide.

[2 marks]

_____ Fe_2O_3 + _____ C ⟶ _____ + _____ CO_2

3 (c) (iii) Give **two** reasons why iron produced in a blast furnace is converted into steel.

[2 marks]

_____

_____

_____

_____

4.2.2.7 Properties of metals and alloys

Question 37 · continued

3 (c) (iv) When a car reaches the end of its useful life, the car body can be:

- recycled
- reused
- sent to landfill.

Give **three** reasons why a steel car body should be recycled and **not** reused or sent to landfill.

[3 marks]

15

4.2.2.7 Properties of metals and alloys

Question 38

June 2017 | CH1HP | Original Q5 | Legacy

5 This question is about the Earth's atmosphere.

5 (a) The Earth's early atmosphere was a mixture of gases.

One theory is that the Earth's early atmosphere had the composition shown in **Table 4**.

Table 4

Gas	Percentage in Earth's early atmosphere (%)
Carbon dioxide	96
Nitrogen	3.5
Oxygen	a trace
Other gases including methane, ammonia, hydrogen and water vapour	0.5

5 (a) (i) Amino acids are at the basis of all life processes.
The simplest amino acid is glycine, NH_2CH_2COOH

Two scientists, Miller and Urey, showed that they could produce glycine from a mixture of methane, ammonia, hydrogen and water.
Miller and Urey concluded that this is how life was formed on Earth.

Suggest **one** reason why this conclusion may **not** be correct.

[1 mark]

5 (a) (ii) Give **three** reasons why the percentage of carbon dioxide in the Earth's atmosphere today is less than the percentage of carbon dioxide in the Earth's early atmosphere.

[3 marks]

4.2.2.7 Properties of metals and alloys

Question 38 · continued

5 (b) **Table 5** shows the boiling points of some gases in the air.

Table 5

Gas	Boiling point in °C
Nitrogen	–196
Oxygen	–183
Carbon dioxide	–79*
Helium	–269
Neon	–246
Argon	–186

*freezes at this temperature

Oxygen from the air is separated by fractional distillation. To do this separation the air is cooled to –200 °C. Most of the gases condense.

5 (b) (i) Name the two gases that would **not** condense at –200 °C.

[1 mark]

_____ and _____

5 (b) (ii) Suggest why carbon dioxide is removed before the air is cooled.

[1 mark]

_____

_____

5 (b) (iii) The liquid at –200 °C is passed into a fractionating column.

Explain why one of the fractions is a mixture of oxygen and one other gas.

[2 marks]

_____

_____

_____

_____

4.2.2.7 Properties of metals and alloys

Question 38 · continued

5 (c) Oxygen is used in the production of steel.

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

The stages for the production of steel from cast iron are:

Stage 1 pass oxygen into molten cast iron

Stage 2 add small amounts of other metals.

Explain why each stage is needed in the production of steel.

[4 marks]

12

4.2.2.7 Properties of metals and alloys

Question 39

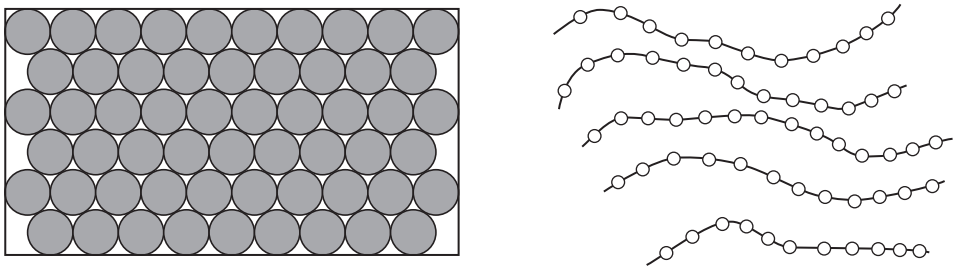
June 2017 | CH2HP | Original Q2 | Legacy

2 **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Metals and thermosoftening polymers have different properties.

Figure 3 shows structures of a metal and a thermosoftening polymer.

Figure 3



Explain how the properties of a metal and a thermosoftening polymer relate to their structures.

In your answer you should describe the structures of a metal and a thermosoftening polymer.

[6 marks]

4.2.2.7 Properties of metals and alloys

Question 40

0 4 This question is about the corrosion of metals.

The corrosion of iron is called rusting.

0 4 . 1 A student investigated the rusting of iron.

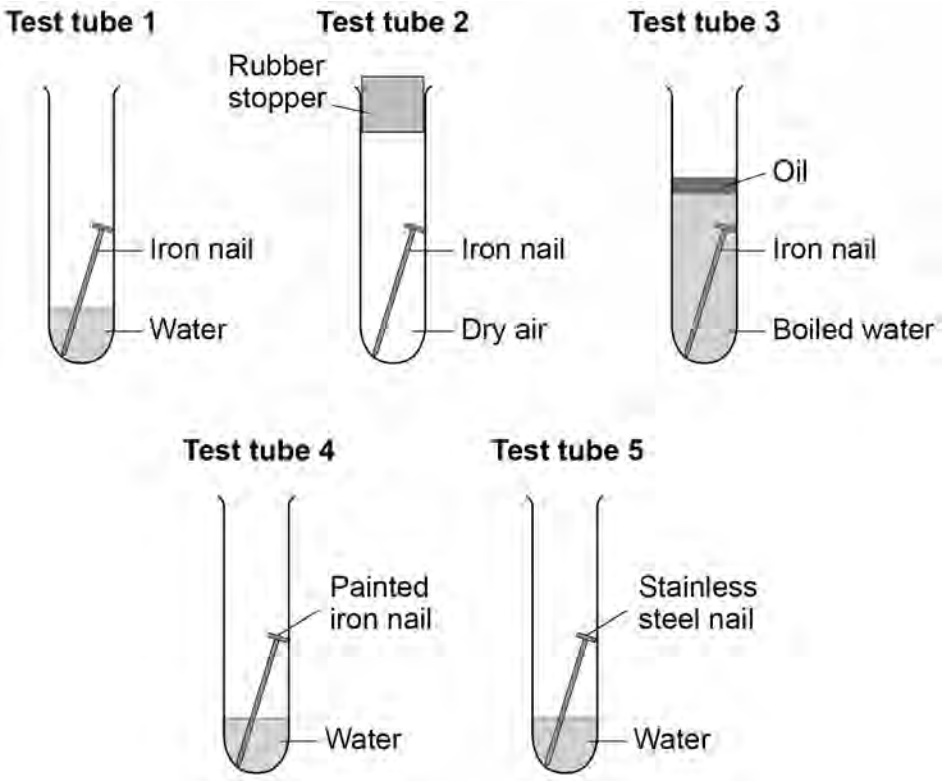
This is the method used.

1. Set up the test tubes as shown in **Figure 4**.

2. Leave the test tubes for 1 week.

3. Examine the nails for signs of rust.

Figure 4



Explain what would happen to the nails in each of the test tubes.

[5 marks]

4.2.2.7 Properties of metals and alloys

Question 40 · continued

0 4 . 2 Magnesium is fixed to some steel ships.

Explain how this prevents the steel from rusting.

[2 marks]

0 4 . 3 Explain why aluminium window frames do **not** corrode after they are made.

[2 marks]

9

4.2.2.7 Properties of metals and alloys

Question 41

November 2021 | 8462/1H | Original Q6

0 6 This question is about metals.

0 6 . 1 **Table 3** shows information about four substances.

Table 3

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

Which substance could be a metal?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 6 . 2 Explain why alloys are harder than pure metals.

[3 marks]

4.2.2.7 Properties of metals and alloys

Question 41 · continued

0 6 . 3 A student wants to compare the reactivity of an unknown metal, **Q**, with that of zinc.

Both metals are more reactive than silver.

The student is provided with:

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

No other chemicals are available.

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

Your method should give valid results.

[4 marks]

8

4.2.2.7 Properties of metals and alloys

Question 42

November 2021 | 8462/2H | Original Q8

0 8 This question is about copper and alloys of copper.

Solders are alloys used to join metals together.

Some solders contain copper.

Table 4 shows information about three solders, **A**, **B** and **C**.

Table 4

Solder	Melting point in °C	Metals in solder
A	183	tin, copper, lead
B	228	tin, copper, silver
C	217	tin, copper, silver

0 8 . 1 Solder **B** and solder **C** are now used more frequently than solder **A** for health reasons.

Suggest **one** reason why.

Use **Table 4**.

[1 mark]

0 8 . 2 Suggest **one** reason why solders **B** and **C** have different melting points.

Use **Table 4.**

[1 mark]

4.2.2.7 Properties of metals and alloys

Question 42 · continued

Copper can be obtained by:

- processing copper ores
- recycling scrap copper.

0 8 . 3 Suggest **three** reasons why recycling scrap copper is a more sustainable way of obtaining copper than processing copper ores.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

Question 8 continues on the next page

4.2.2.7 Properties of metals and alloys

Question 42 · continued

Copper is extracted from low-grade ores by phytomining.

0 8 . 4 Describe how copper is extracted from low-grade ores by phytomining.

[4 marks]

0 8 . 5 Phytomining has **not** been widely used to extract copper.

Suggest **two** reasons why.

[2 marks]

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4.2.2.7 Properties of metals and alloys

Question 43

June 2023 | 8462/1H | Original Q6

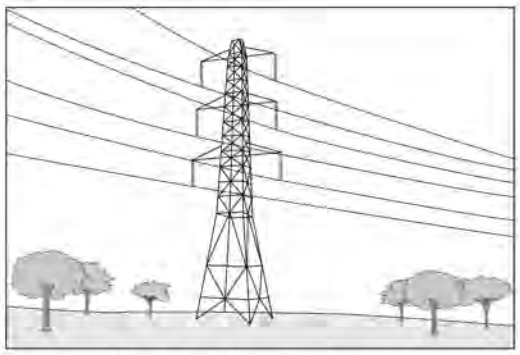
0 6 This question is about uses of metals in electrical wires.

Electrical wires can be made from:

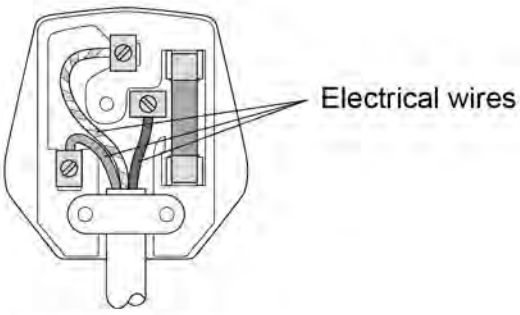
- aluminium
- copper
- silver.

Figure 6 shows three uses of electrical wires.

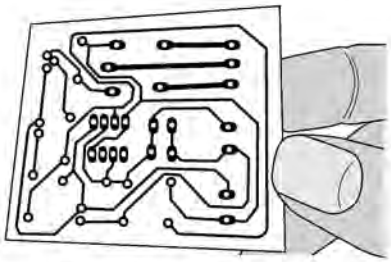
Figure 6



Overhead power cables



Wiring in homes



Printed circuit boards

Table 5 shows information about the metals.

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

Table 5

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

4.2.2.7 Properties of metals and alloys

Question 43 · continued

0 6 . 1 Evaluate the use of aluminium, copper and silver for the types of electrical wires shown in **Figure 6**.

Use **Table 5**.

[4 marks]

0 6 . 2 Describe how metals conduct electricity.

[3 marks]

Question 6 continues on the next page

4.2.2.7 Properties of metals and alloys

Question 43 · continued

0 6 . 3 Electrical wires are usually made of pure metals and **not** alloys. This is because pure metals are better electrical conductors.

Suggest why alloys do **not** conduct electricity as well as pure metals.

Answer in terms of structure and bonding.

[2 marks]

9

4.2.2.7 Properties of metals and alloys

Question 44

June 2024 | 8462/1H | Original Q7

0 7 This question is about iron.

0 7 . 1 Iron is a metal.

Describe how iron conducts thermal energy.

[2 marks]

0 7 . 2 Pure iron is too soft for many uses.

Explain why mixing iron with other metals makes alloys which are harder than pure iron.

[3 marks]

Question 7 continues on the next page

4.2.2.7 Properties of metals and alloys

Question 44 · continued

0 7 . 3 When iron reacts with chlorine, 0.12 mol of iron reacts with 0.18 mol of chlorine (Cl_2).

Which is the correct equation for the reaction?

[1 mark]

Tick (✓) **one** box.

$Fe + Cl_2 \rightarrow FeCl_2$ ☐

$Fe + 3Cl_2 \rightarrow FeCl_6$ ☐

$2Fe + Cl_2 \rightarrow 2FeCl$ ☐

$2Fe + 3Cl_2 \rightarrow 2FeCl_3$ ☐

The most common oxides of iron are Fe_2O_3 and Fe_3O_4

0 7 . 4 What is the ratio of the numbers of ions in Fe_3O_4?

[1 mark]

Tick (✓) **one** box.

2 Fe^{2+} : 1 Fe^{3+} : 4 O^{2-} ☐

1 Fe^{2+} : 2 Fe^{3+} : 4 O^{2-} ☐

3 Fe^{2+} : 4 O^{2-} ☐

3 Fe^{3+} : 4 O^{2-} ☐

Question 44 · continued

0 7 . 5 Calculate the percentage (%) by mass of iron in Fe_3O_4

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

[3 marks]

Percentage by mass of iron = _____ %

0 7 . 6 Fe_2O_3 reacts with carbon to produce carbon dioxide.

The equation for the reaction is:

$$2\,Fe_2O_3(s) + 3\,C(s) \rightarrow 4\,Fe(s) + 3\,CO_2(g)$$

Calculate the volume of carbon dioxide gas at room temperature and pressure that is produced from 40.0 kg of Fe_2O_3 using excess carbon.

Relative formula mass (M_r): Fe_2O_3 = 160

The volume of 1 mole of any gas at room temperature and pressure is 24 dm^3.

[5 marks]

Volume of carbon dioxide = _____ dm^3

15

4.2.2.7 Properties of metals and alloys

Question 45

0 6 This question is about materials used to make bicycles.

Figure 6 shows a bicycle.

Figure 6



Table 3 shows information about two materials used to make bicycle frames.

Table 3

	Material	
	Aluminium alloy	**Bamboo**
Raw material	aluminium ore	bamboo plant
Cost of frame in £	250	1500
Strength in arbitrary units	290	193
Mass in kilograms	1.6	2.4
Lifespan in years	6–10	10–15
One method of disposal at end of life	recycled to make new products	burned to produce heat energy

4.2.2.7 Properties of metals and alloys

Question 45 · continued

0 6 . 1 Evaluate the use of aluminium alloy and of bamboo for making bicycle frames.

Use **Table 3**.

[6 marks]

0 6 . 2 Explain why aluminium alloy bicycle frames do **not** need protection from corrosion.

[2 marks]

Question 6 continues on the next page

4.2.2.7 Properties of metals and alloys

Question 45 · continued

0 6 . 3 Bicycle chains are made from an alloy of iron.

Bicycle chains rust without protection.

Paint is **not** used to protect bicycle chains from rusting.

Suggest how bicycle chains can be protected from rusting.

[1 mark]

0 6 . 4 Bicycle frames can also be made from a composite of carbon fibres embedded in a polymer resin.

What description is given in this composite to:

- the carbon fibre component
- the polymer resin component?

[2 marks]

Carbon fibre _____

Polymer resin _____

11