

1

This question is about mixtures and analysis.

(a) Which **two** substances are mixtures?

Tick **two** boxes.

Air

☐

Carbon dioxide

☐

Graphite

☐

Sodium Chloride

☐

Steel

☐

(2)

(b) Draw **one** line from each context to the correct meaning.

Context

Meaning

Pure substance
in chemistry

A substance that has had nothing
added to it

A single element or a single compound

A substance containing only atoms which
have different numbers of protons

Pure substance
in everyday life

A substance that can be separated by
filtration

A useful product made by mixing
substances

(2)

(c) What is the test for chlorine gas?

Tick **one** box.

A glowing splint relights

☐

A lighted splint gives a pop

☐

Damp litmus paper turns white

☐

Limewater turns milky

☐

(1)

(d) A student tested a metal chloride solution with sodium hydroxide solution.

A brown precipitate formed.

What was the metal ion in the metal chloride solution?

Tick **one** box.

Calcium

☐

Copper(II)

☐

Iron(II)

☐

Iron(III)

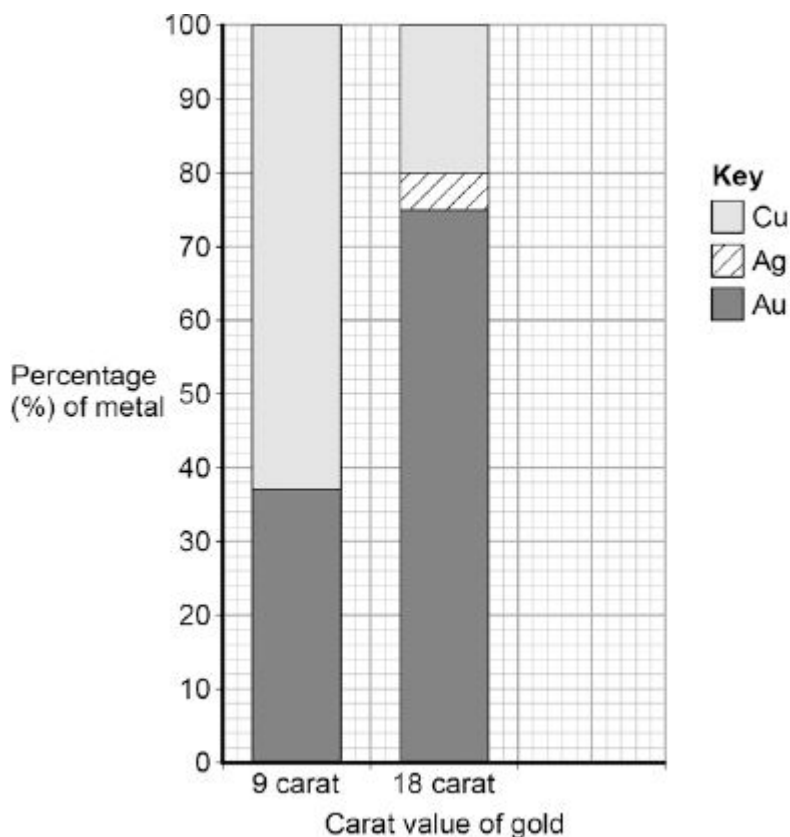
☐

(1)
(Total 6 marks)

2

Gold is mixed with other metals to make jewellery.

The figure below shows the composition of different carat values of gold.



- (a) What is the percentage of gold in 12 carat gold?

Tick **one** box.

12 %

☐

30 %

☐

50 %

☐

80 %

☐

(1)

- (b) Give the percentage of silver in 18 carat gold.

Use the figure above to answer this question.

Percentage = %

(1)

- (c) Suggest **two** reasons why 9 carat gold is often used instead of pure gold to make jewellery.

1

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2

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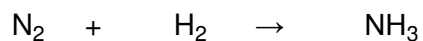
(2)

(Total 4 marks)

3

- (a) Nitrogen and hydrogen are passed over iron to produce ammonia in the Haber Process.

Balance the equation for the reaction.



(1)

- (b) What is iron used for in the Haber process?

Tick **one** box.

catalyst

☐

fuel

☐

monomer

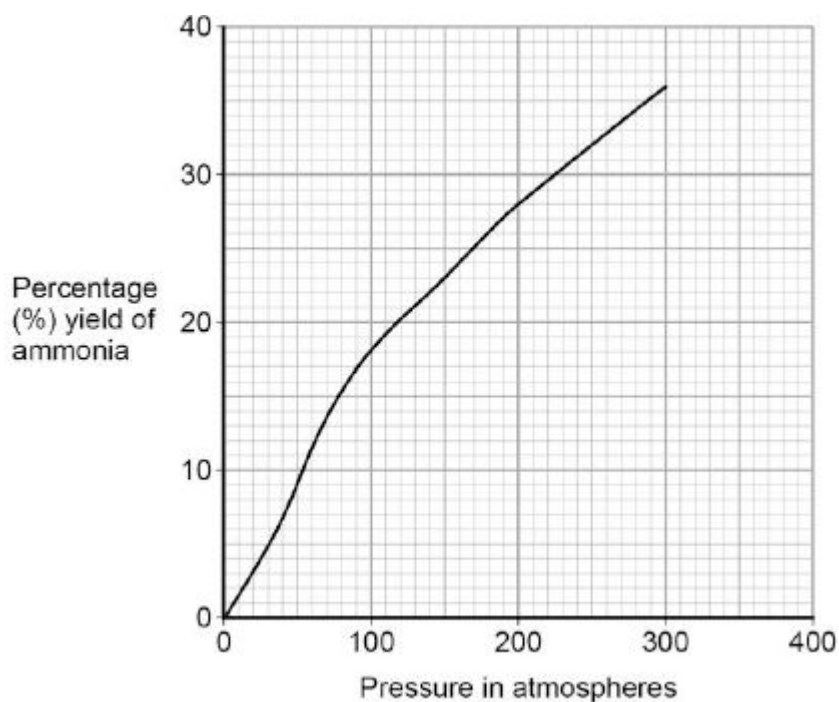
☐

reactant

☐

(1)

- (c) The figure below shows how the percentage yield of ammonia changes with pressure.



Describe the trend shown in the figure above.

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(1)

- (d) Use the figure above to determine the difference in percentage yield of ammonia at 150 atmospheres pressure and 250 atmospheres pressure.

Difference in percentage yield of ammonia = %

(2)

(Total 5 marks)

4

Water from a lake in the UK is used to produce drinking water.

- (a) What are the two main steps used to treat water from lakes?

Give a reason for each step.

Step 1

Reason

Step 2

Reason

(2)

- (b) Explain why it is more difficult to produce drinking water from waste water than from water in lakes.

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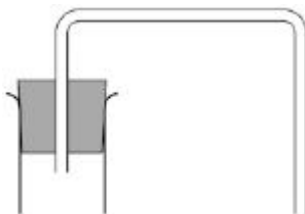
(3)

- (c) Some countries make drinking water from sea water.

Complete the figure below to show how you can distil salt solution to produce and collect pure water.

Label the following:

- pure water
- salt solution



(3)

- (d) How could the water be tested to show it is pure?

Give the expected result of the test for pure water.

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(2)

- (e) Why is producing drinking water from sea water expensive?

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(1)

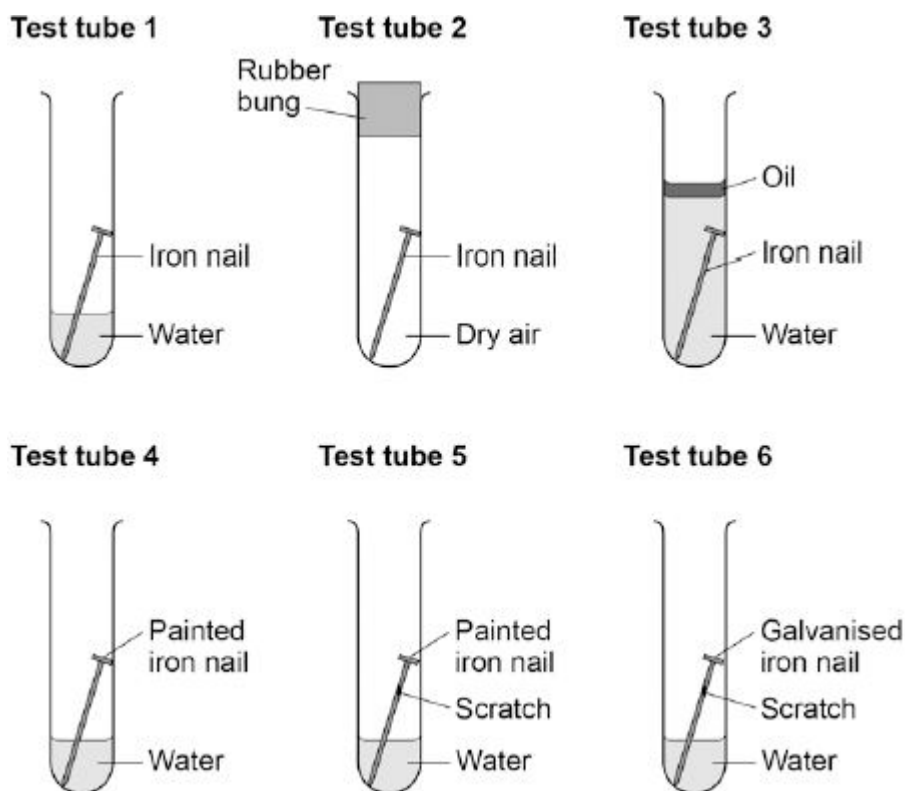
(Total 11 marks)

5

The figure below shows six test tubes a student set up to investigate the rusting of iron.

This is the method used for each test tube.

1. Measure the mass of the nail using a balance.
2. Leave the nail in the test tube for 6 days.
3. Measure the mass of the nail after 6 days.



The table below shows the student's measurements.

Test tube	Mass of nail in g	Mass of nail after 6 days in g
1	8.45	8.91
2	8.46	8.46
3	8.51	8.51
4	9.65	9.65
5	9.37	9.45
6	9.79	9.79

(a) What is the resolution of the balance the student used?

Tick **one** box.

$1 \times 10^{-3} \text{ g}$ $1 \times 10^{-2} \text{ g}$ $1 \times 10^{-1} \text{ g}$ $1 \times 10^2 \text{ g}$ **(1)**

- (b) Calculate the difference in percentage increase in mass after 6 days of the nail in test tube **1** and the nail in test tube **5**.

Give your answer to **three** significant figures.

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Difference in percentage increase in mass = %

(4)

- (c) Use the results of the student's investigations to draw conclusions about the factors affecting the rusting of iron. Include an evaluation of the effectiveness of different coatings at preventing the rusting of iron.

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(6)

- (d) Rust is hydrated iron(III) oxide.

Complete the word equation for the reaction.

..... + + → hydrated iron(III) oxide

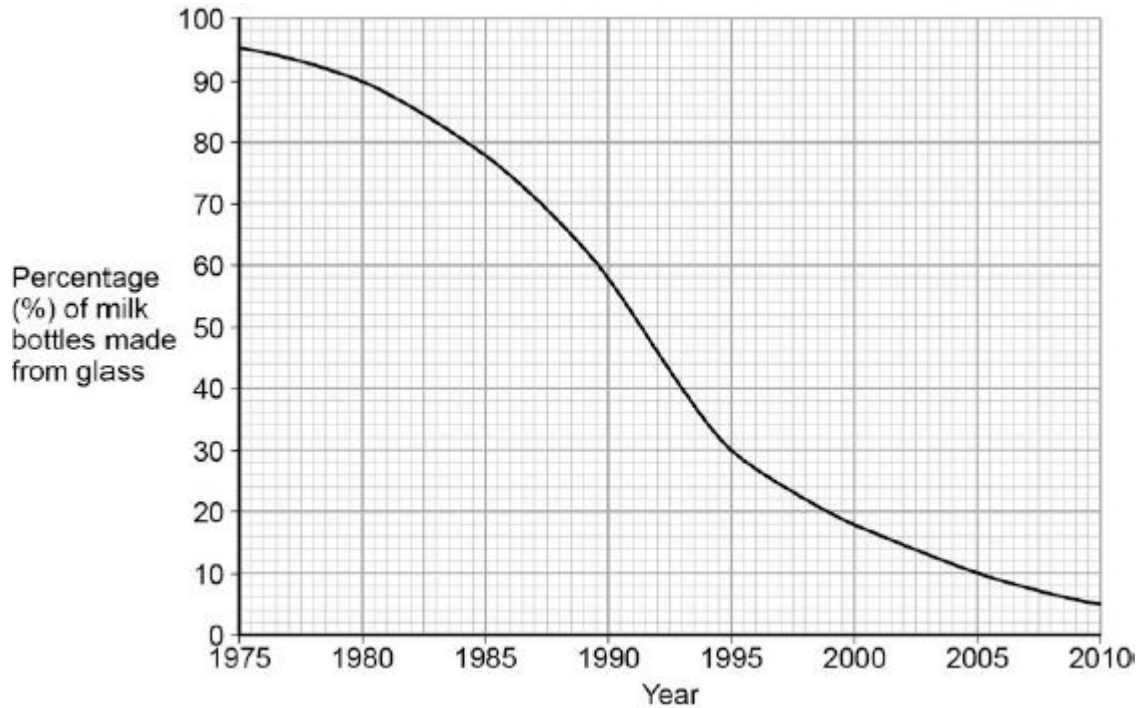
(2)

(Total 13 marks)

6

Plastic and glass can be used to make milk bottles.

The figure below shows the percentage of milk bottles made from glass between 1975 and 2010.



- (a) Plot the points and draw a line on the figure above to show the percentage of milk bottles made from materials **other** than glass between 1975 and 2010.

(3)

- (b) The table below gives information about milk bottles.

	Glass milk bottle	Plastic milk bottle
Raw materials	Sand, limestone, salt	Crude oil
Bottle material	Soda-lime glass	HD poly(ethene)
Initial stage in production of bottle material	Limestone and salt used to produce sodium carbonate.	Production of naphtha fraction.
Maximum temperature in production process	1600 °C	850 °C
Number of times bottle can be used for milk	25	1
Size(s) of bottle	0.5 dm ³	0.5 dm ³ , 1 dm ³ , 2 dm ³ , 3 dm ³
Percentage (%) of recycled material used in new bottles	50 %	10 %

Evaluate the production and use of bottles made from soda-lime glass and those made from HD poly(ethene).

Use the information given and your knowledge and understanding to justify your choice of material for milk bottles.

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(6)
(Total 9 marks)

7

Fertilisers are used to improve agricultural productivity.

- (a) Ammonium nitrate is used in fertilisers.

Name the **two** compounds used to manufacture ammonium nitrate.

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(1)

- (b) A fertiliser contains the following information on the label:

NPK value = 14 : 11 : 11

Explain why this information is useful to farmers.

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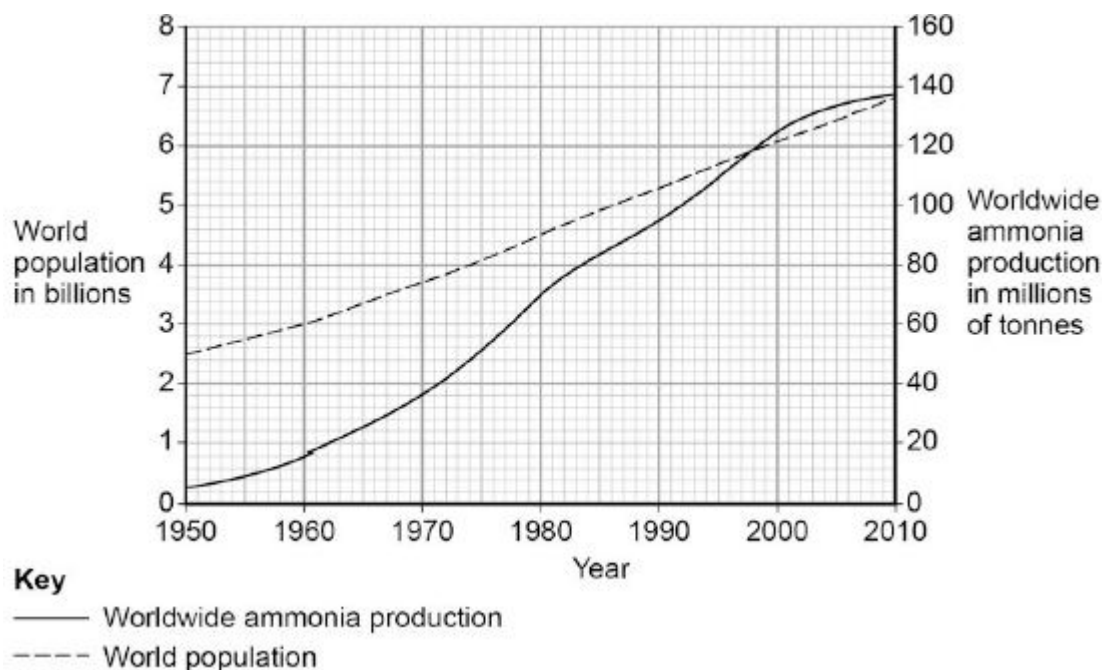
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(2)

- (c) The figure below shows worldwide ammonia production and world population from 1950 to 2010.



Use the figure above and your knowledge to explain the relationship between ammonia production and world population.

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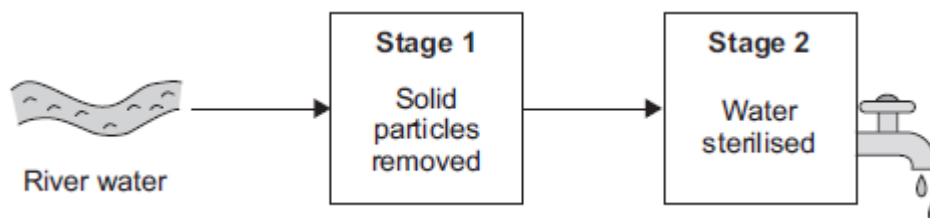
(3)
(Total 6 marks)

8

This question is about water.

River water needs to be treated before it is safe to drink.

(a) The diagram shows two stages of the treatment of river water.



(i) What is the name of the process used to remove solid particles in **Stage 1**?

Tick (✓) **one** box.

Crystallisation

☐

Fermentation

☐

Filtration

☐

(1)

(ii) What is added in **Stage 2** to sterilise the water?

Tick (✓) **one** box.

Chlorine

☐

Fluoride

☐

Potassium

☐

(1)

- (b) Toxic substances in river water are removed by adding very small amounts of iron oxide nanoparticles.

- (i) How is the size of nanoparticles different from normal-sized particles?

.....

(1)

- (ii) Nanoparticles are needed in only very small amounts.

Suggest why.

.....

(1)

- (c) In certain areas of the UK, tap water contains aluminium ions.

What would you **see** when sodium hydroxide solution is added drop by drop to tap water containing aluminium ions?

.....

(2)

(Total 6 marks)

9

This question is about copper.

- (a) Copper can be extracted by smelting copper-rich ores in a furnace.

The equation for one of the reactions in the smelting process is:

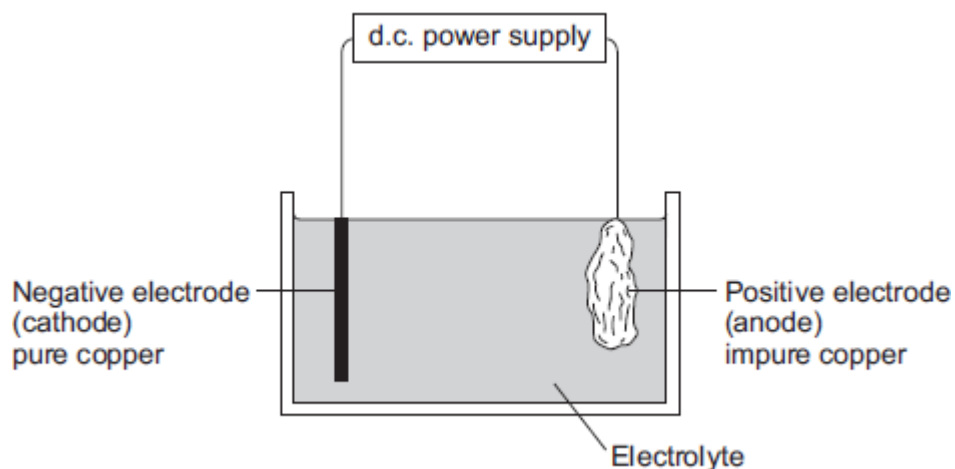


Explain why there would be an environmental problem if sulfur dioxide gas escaped into the atmosphere.

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(2)

- (b) The impure copper produced by smelting is purified by electrolysis, as shown below.



Copper atoms are oxidised at the positive electrode to Cu^{2+} ions, as shown in the half equation.



- (i) How does the half equation show that copper atoms are oxidised?

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(1)

- (ii) The Cu^{2+} ions are attracted to the negative electrode, where they are reduced to produce copper atoms.

Write a balanced half equation for the reaction at the negative electrode.

.....

(1)

- (iii) Suggest a suitable electrolyte for the electrolysis.

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(1)

- (c) Copper metal is used in electrical appliances.

Describe the bonding in a metal, and explain why metals conduct electricity.

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(4)

- (d) Soil near copper mines is often contaminated with low percentages of copper compounds.

Phytomining is a new way to extract copper compounds from soil.

Describe how copper compounds are extracted by phytomining.

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(3)

- (e) A compound in a copper ore has the following percentage composition by mass:

55.6% copper, 16.4% iron, 28.0% sulfur.

Calculate the empirical formula of the compound.

Relative atomic masses (A_r): S = 32; Fe = 56; Cu = 63.5

You must show all of your working.

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Empirical formula =

(4)
(Total 16 marks)

10

This question is about metals.

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

Tick (✓) **one** box.

aluminium

☐

gold

☐

magnesium

☐

(1)

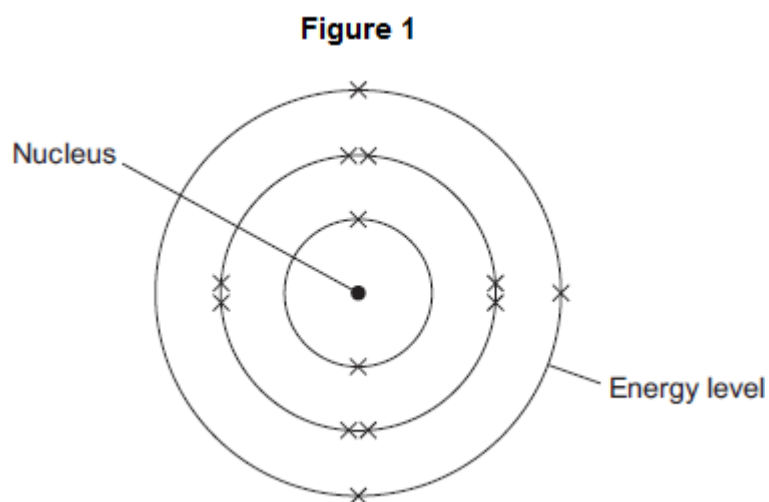
- (b) Complete the sentence.

Aluminium is an element because aluminium is made of

only one type of

(1)

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



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

electrons	ions	protons	neutrons	shells
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The nucleus of an aluminium atom contains and

(2)

- (ii) Complete the sentence.

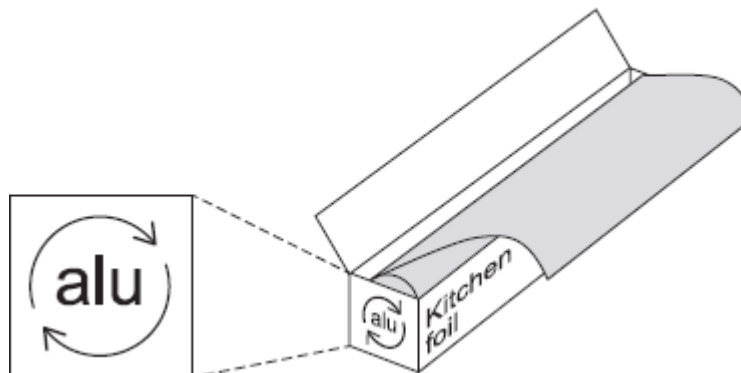
In the periodic table, aluminium is in Group

(1)

- (d) Aluminium is used for kitchen foil.

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

Figure 2



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

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

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(1)

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

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(2)

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

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

Give a reason for your answer.

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(2)

(Total 10 marks)

11

Copper is a transition metal.

- (a) (i) Where is copper in the periodic table?

Tick (✓) **one** box.

in the central block

☐

in Group 1

☐

in the noble gas group

☐

(1)

- (ii) What is a property of copper?

Tick (✓) **one** box.

breaks easily

☐

conducts electricity

☐

does not conduct heat

☐

(1)

- (b) Copper ores are quarried by digging large holes in the ground, as shown in **Figure 1**.

Figure 1



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Give **two** reasons why quarrying is bad for the environment.

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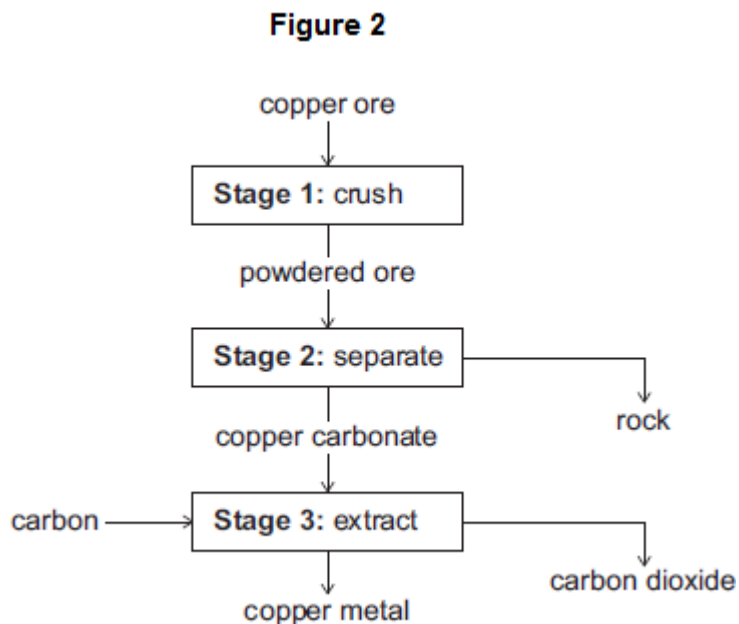
(2)

- (c) Some copper ores contain only 2% copper.

Most of the ore is rock that is not needed.

In one ore, the main compound is copper carbonate (CuCO_3).

Figure 2 shows the stages used in the extraction of copper from this ore.



- (i) Why is **Stage 2** important?

.....

(1)

- (ii) The equation for the reaction in **Stage 3** is:



From the symbol equation, a company calculated that 247 tonnes of copper carbonate are needed to produce 127 tonnes of copper and 132 tonnes of carbon dioxide are released.

Calculate the mass of carbon needed to make 127 tonnes of copper.

copper carbonate	+	carbon	→	copper	+	carbon dioxide
247 tonnes	 tonnes		127 tonnes		132 tonnes

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(2)

- (iii) Suggest **one** reason why it is important for the company to calculate the mass of reactants in **Stage 3**.

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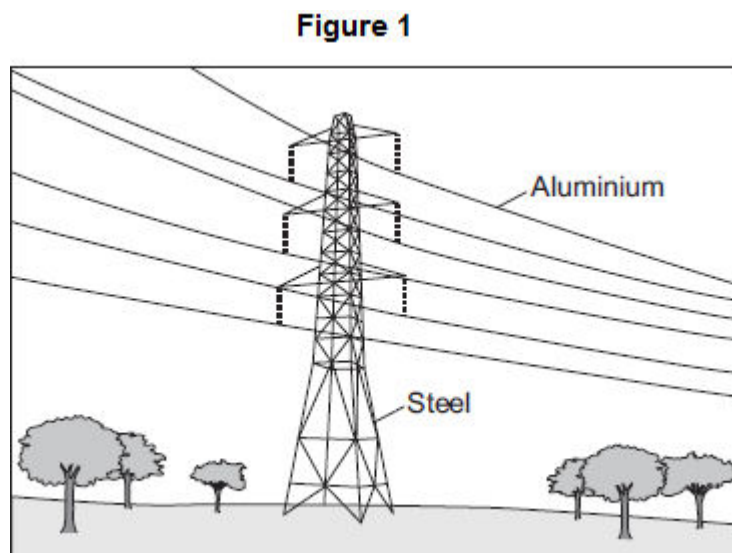
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(1)
(Total 8 marks)

12

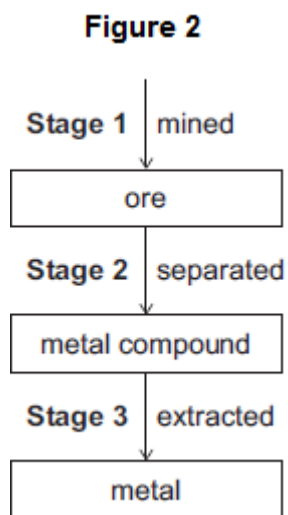
This question is about metals.

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



- (a) An ore contains a metal compound.

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



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

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(2)

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

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

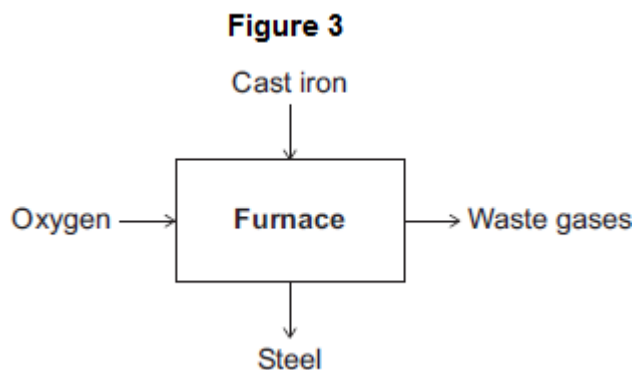
Give **one** reason why.

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(1)

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



Describe how cast iron is converted into steel.

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

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(2)

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

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

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(1)

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

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(2)

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

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(2)

(Total 10 marks)

13

This question is about salts.

- (a) Salt (sodium chloride) is added to many types of food.

Sodium chloride is produced by reacting sodium with chlorine.



The diagram shows what happens to atoms of sodium and chlorine in this reaction.

The dots (•) and crosses (×) represent electrons.

Only the outer electrons are shown.



Describe, in terms of electrons, what happens when a sodium atom reacts with a chlorine atom to produce sodium chloride.

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(3)

- (b) Lack of iodine can affect the learning ability of children.

One idea is that salt (sodium chloride) should have iodine added.

- (i) Iodine consists of simple molecules.

What is a property of substances that have simple molecules?

Tick (✓) **one** box.

Have no overall electric charge

☐

Have high boiling points

☐

Have giant covalent structures

☐

(1)

- (ii) Which one of the following questions cannot be answered by science alone?

Tick (✓) **one** box.

How much sodium chloride is in food?

☐

What harm does a lack of iodine do?

☐

Should iodine be added to salt in food?

☐

Give **one** reason why this question cannot be answered by science alone.

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(2)

(c) A student produced the salt ammonium nitrate by adding an acid to ammonia solution.

(i) Name the acid used.

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(1)

(ii) Use the correct answer from the box to complete the sentence.

an acid	an alkali	a salt
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Ammonia solution (ammonium hydroxide) is

(1)

(iii) The student added a few drops of a solution which changed colour when the reaction was complete.

Complete the sentence.

The solution added is an

(1)

(d) Farmers buy solid ammonium nitrate in poly(ethene) sacks.

(i) How is solid ammonium nitrate made from a solution of ammonium nitrate?

Tick (✓) **one** box.

Crystallisation

☐

Decomposition

☐

Electrolysis

☐

(1)

- (ii) Why do farmers use ammonium nitrate on their fields?

.....
.....

(1)

- (iii) The properties of poly(ethene) depend on the reaction conditions when it is made.

State **one** reaction condition that can be changed when making poly(ethene).

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.....

(1)

(Total 12 marks)

14

This question is about metals and alloys.

- (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.

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(4)

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

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(2)

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

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

Why is Nitinol used in dental braces?

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.....

(1)

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

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

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(1)

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

Complete the sentence.

Aluminium is manufactured by the electrolysis of a molten mixture of cryolite and

.....

(1)

(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?

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(1)

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

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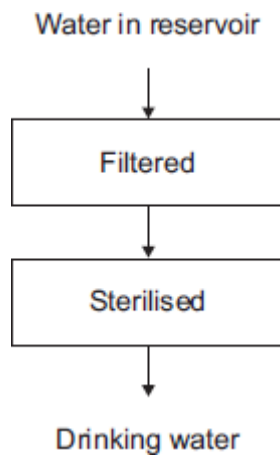
(1)

(Total 11 marks)

15

This question is about drinking water.

- (a) The flow diagram below shows how water is made suitable for drinking.



- (i) What is removed when the water is filtered?

Tick (✓) **one** box.

Gases

☐

Liquids

☐

Solids

☐

(1)

- (ii) What is used to sterilise the water?

Tick (✓) **one** box.

Carbon

☐

Chlorine

☐

Sodium chloride

☐

(1)

- (iii) Why is the water sterilised?

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(1)

- (b) Water can be purified by distillation.

Drinking water is **not** usually purified by distillation because distillation is expensive.

Complete the sentence.

Distillation is expensive because it requires a lot of

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(1)

- (c) Why do some water companies add fluoride to drinking water?

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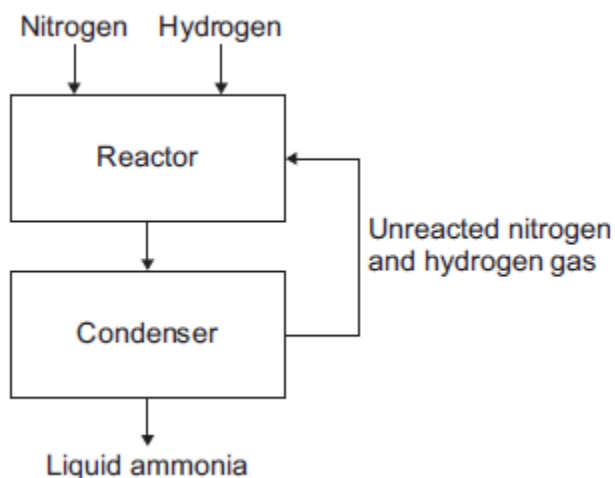
(1)

(Total 5 marks)

16

A flow diagram of the Haber process is shown below.

The Haber process produces ammonia from nitrogen and hydrogen.



- (a) Use the correct answer from the box to complete the sentence.

air	limestone	natural gas
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Hydrogen is obtained from

(1)

- (b) In the reactor, nitrogen and hydrogen at a high pressure are heated and passed over a catalyst.

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

25	100	450
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The temperature in the reactor is °C

(1)

- (ii) Use the correct answer from the box to complete the sentence.

copper	iron	nickel
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The catalyst used in the reactor is

(1)

- (iii) How does a catalyst speed up a reaction?

Tick (✓) **one** box.

The catalyst lowers the activation energy.

☐

The catalyst gives the reactants extra energy.

☐

The catalyst increases the pressure in the reactor.

☐

(1)

- (c) A mixture of gases leaves the reactor.

The mixture contains ammonia, nitrogen and hydrogen.

Describe what happens to this mixture of gases in the condenser.

Use the flow diagram to help you.

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(3)
(Total 7 marks)

17

This question is about reversible reactions and chemical equilibrium.

- (a) Reversible reactions can reach equilibrium in a closed system.

- (i) What is meant by a closed system?

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(1)

- (ii) Explain why, when a reversible reaction reaches equilibrium, the reaction appears to have stopped.

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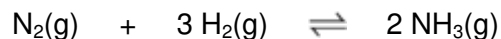
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(2)

- (b) In the Haber process, the reaction of nitrogen with hydrogen to produce ammonia is reversible.



- (i) Name a natural resource from which hydrogen is produced.

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(1)

- (ii) The Haber process uses a catalyst to speed up the reaction.

Explain how a catalyst speeds up a reaction.

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(2)

- (iii) What happens to the amount of ammonia produced at equilibrium if the pressure is increased?

Give a reason for your answer.

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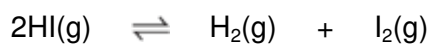
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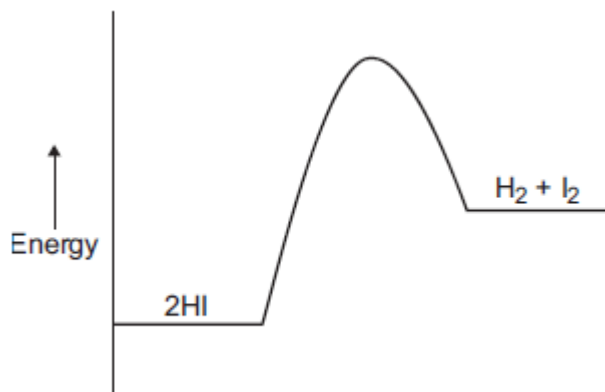
(2)

- (c) The decomposition of hydrogen iodide into hydrogen and iodine is reversible.



The forward reaction is endothermic.

The energy level diagram shown below is for the forward reaction.



- (i) Draw an arrow to show the activation energy on the diagram.

(1)

- (ii) How does the diagram show that the reaction is endothermic?

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(1)

- (iii) Suggest what effect, if any, increasing the temperature will have on the amount of hydrogen iodide at equilibrium.

Give a reason for your answer.

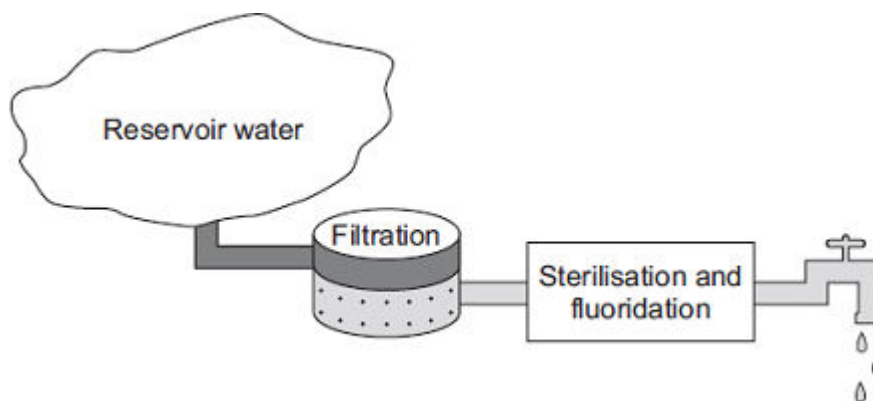
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(2)

(Total 12 marks)

18

The diagram shows three stages in the treatment of reservoir water.



- (a) (i) What is separated from the reservoir water during filtration?

Tick (✓) **one** box.

Bacteria

☐

Dissolved nitrates

☐

Solids

☐

(1)

- (ii) What is added to sterilise the water?

Tick (✓) **one** box.

Calcium

☐

Chlorine

☐

Magnesium

☐

(1)

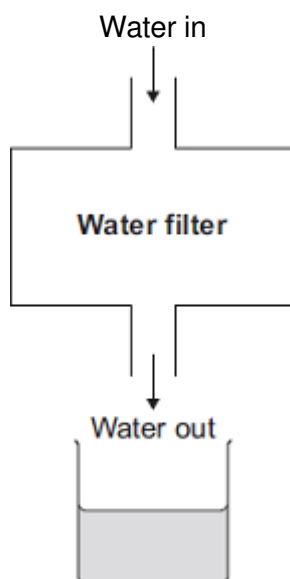
- (iii) State **one** advantage of adding fluoride to drinking water.

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(1)

- (b) The diagram shows a water filter used in the home.



A student collected a sample of water from the filter.

The student could show that the filtered water contains dissolved salts without using a chemical test.

Describe how.

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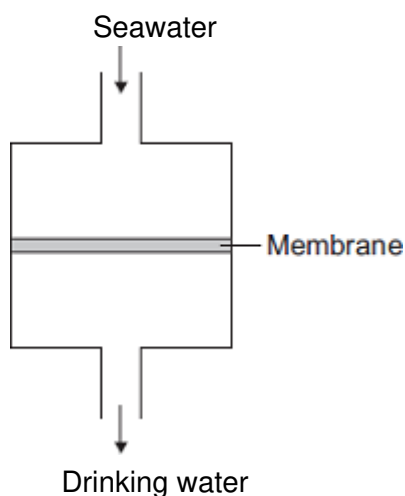
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(2)

- (c) Seawater is forced through a membrane to make drinking water.



Suggest why water molecules can pass through the membrane, but sodium ions and chloride ions cannot.

.....

.....

(1)
(Total 6 marks)

19

Iron will rust in damp air.

- (a) Iron reacts with water and oxygen to produce rust.

- (i) As iron rusts there is a colour change.

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

During the reaction iron changes from grey to

blue brown green

(1)

- (ii) Rust is hydrated iron oxide.

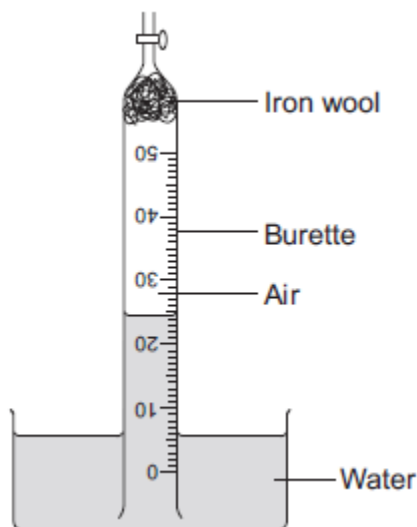
Write a word equation for the reaction of iron with oxygen and water.

.....

(1)

- (b) A student set up the apparatus shown in **Figure 1**.

Figure 1

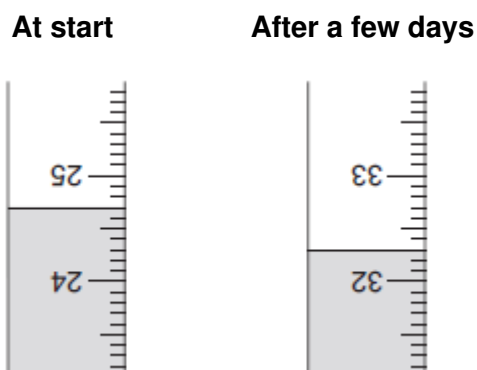


The student left the apparatus for a few days.

The water level in the burette slowly went up and then stopped rising.

Figure 2 shows the water level in the burette at the start of the experiment and after a few days.

Figure 2



- (i) Complete the table below to show the reading on the burette after a few days.

Burette reading at start	24.7 cm ³
Burette reading after a few dayscm ³

(1)

- (ii) Calculate the volume of oxygen used up in the reaction.

.....

Volume = cm³

(1)

- (iii) The percentage of air that is oxygen can be calculated using the equation:

$$\text{percentage of air that is oxygen} = \frac{\text{volume of oxygen used up}}{\text{volume of air at start}} \times 100$$

The student **cannot** use his results to calculate the correct percentage of air that is oxygen.

Explain why.

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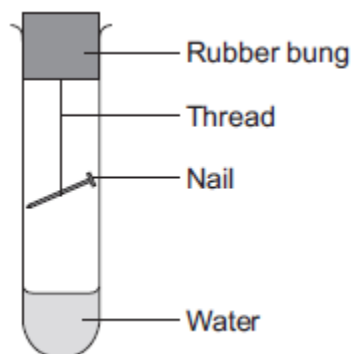
(2)

- (c) A student investigated the rusting of an iron nail at different temperatures.

This is the method the student used:

- measure the mass of a nail
- set up apparatus as shown in **Figure 3**
- leave for 3 days
- measure the mass of the rusted nail.

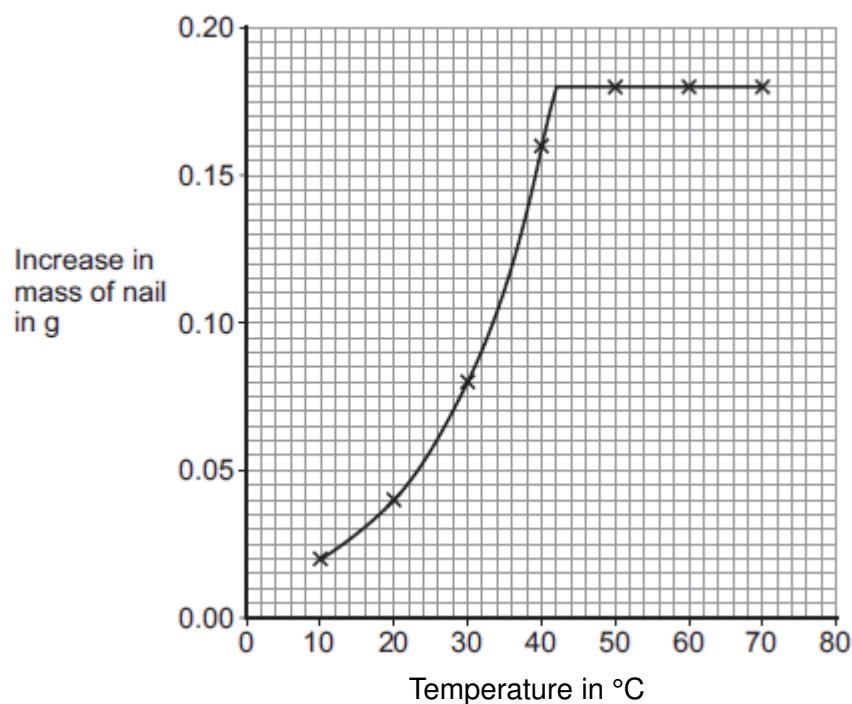
Figure 3



The student repeated the experiment at different temperatures using a new, identical, nail each time.

The student's results are shown on the graph in **Figure 4**.

Figure 4



- (i) Why does the mass of the nail increase when it rusts?

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(1)

- (ii) Use the graph to describe the relationship between the temperature and the increase in mass of the nail.

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(3)

- (iii) The increase in mass of the nail after 3 days is a measure of the rate of rusting.

The student's graph does **not** correctly show how increasing the temperature above 42 °C changes the rate of rusting.

How could the experiment be changed to show the effect of temperatures above 42 °C on the rate of rusting?

Give a reason for your answer.

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(2)

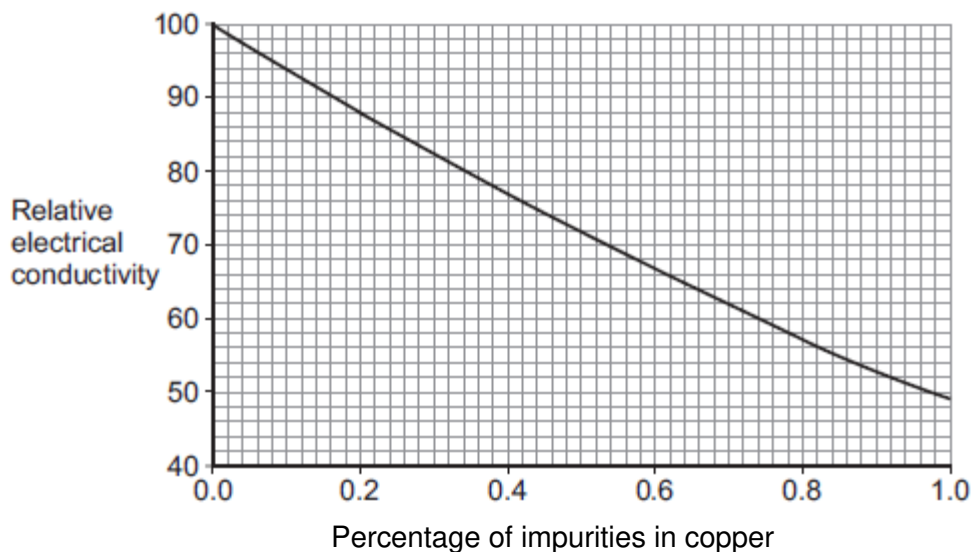
(Total 12 marks)

20

This question is about copper.

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

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



Copper extracted by smelting is about 99% pure.

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

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

.....

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.....

(2)

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

Read the information in the box.

Copper extraction

World demand for copper for the year 2011 was about 20 million tonnes.

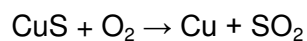
World reserves of copper are estimated to be 700 million tonnes.

Most of the copper used is obtained from copper ores, which are mined.

The copper ore chalcopyrite is heated in a furnace to produce copper sulfide, CuS

The furnace is heated by burning fossil fuels.

Air is then blown through the hot copper sulfide, to produce copper and sulfur dioxide.



A scientist made the statement: 'Copper should be recycled'.

Use the information in the box and your own knowledge and understanding to justify the scientist's statement.

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Extra space

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(6)

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

Describe how copper compounds are obtained by phytomining.

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(3)

(Total 11 marks)

21

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

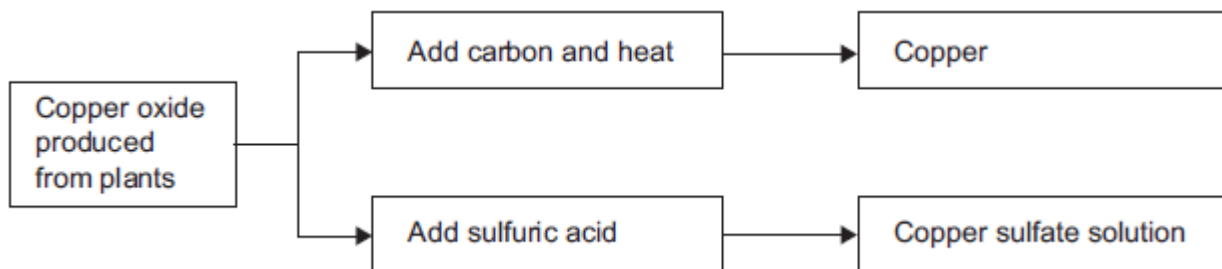
One way to extract the copper is to grow plants on the land.

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.
phytominning.
polymerisation.

(1)

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

carbon dioxide.
oxygen.
sulfur dioxide.

(1)

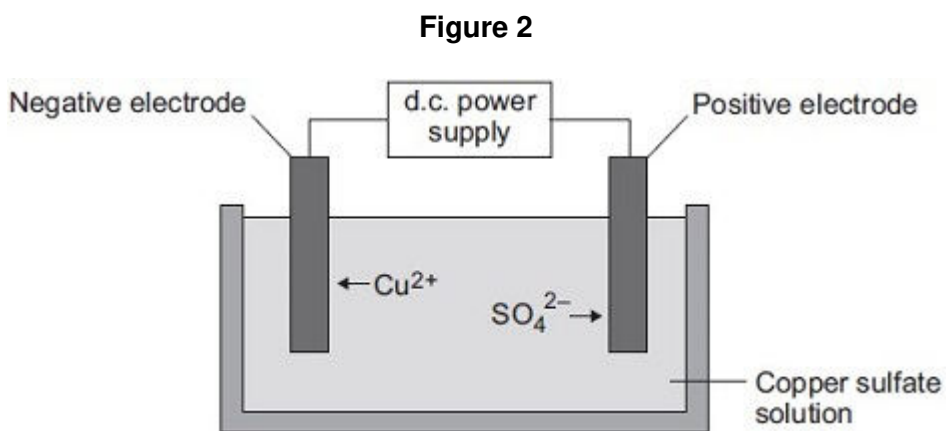
(b) Copper is produced from copper sulfate solution by displacement using iron or by electrolysis.

- (i) Complete the word equation.

copper sulfate + iron \longrightarrow +

(2)

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



Why do copper ions go to the negative electrode?

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(1)

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

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(2)

(Total 8 marks)

22

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

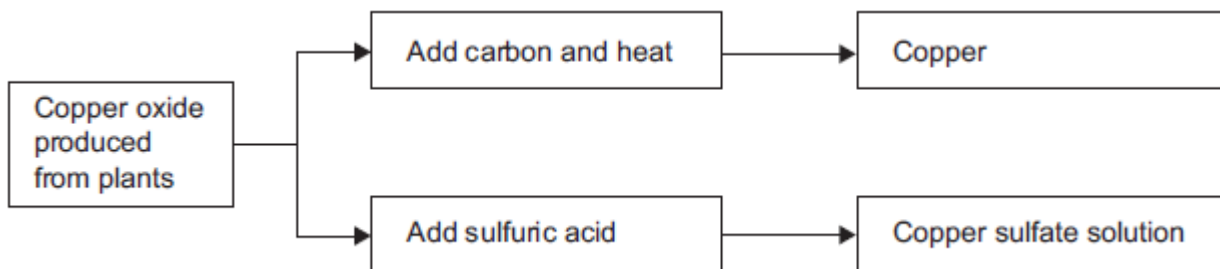
One way to extract the copper is to grow plants on the land.

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) (i) Complete the sentence.

Using plants to extract metals is called

(1)

- (ii) Suggest **two** reasons why copper from these areas of land is **not** extracted by smelting.

.....

(2)

- (iii) Complete and balance the chemical equation for the reaction of copper oxide with carbon.



(2)

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

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

Give **two** reasons why scrap iron is used to displace copper.

.....

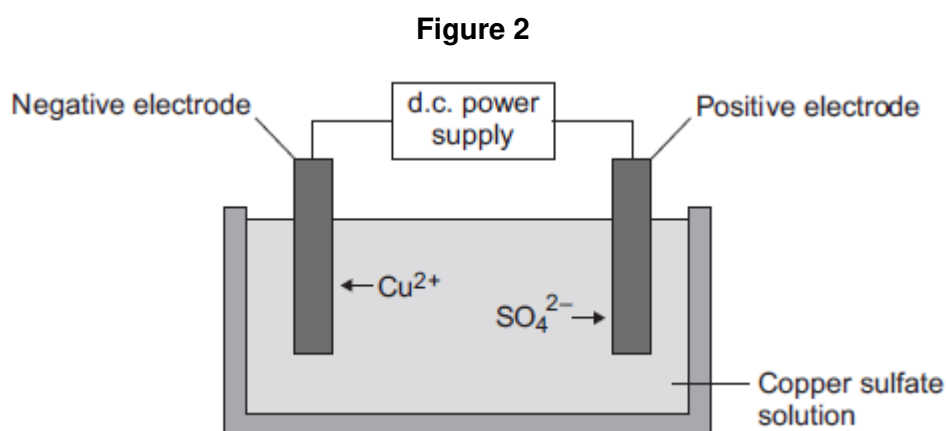
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(2)

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



Describe what happens to the copper ions during electrolysis.

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(2)
(Total 9 marks)



/iStock/Thinkstock © Zametalov/iStock/Thinkstock

- (a) Nitinol can return to its original shape after being deformed.

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

Nitinol is a shape memory

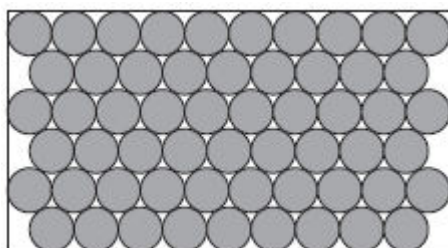
alloy.
catalyst.
polymer.

(1)

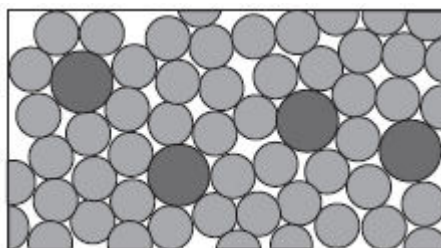
- (b) **Figure 1** shows the arrangement of atoms in a pure metal and in a mixture of metals.

Figure 1

Pure metal



Mixture of metals



The mixture of metals is harder than the pure metal.

Use **Figure 1** to explain why.

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(2)

- (c) Gold and stainless steel are also used for dental braces.

Suggest **two** factors to consider when choosing which metal to use for dental braces.

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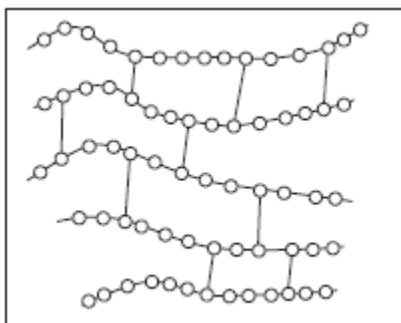
(2)

- (d) A thermosetting polymer is used to hold dental braces on the teeth.

Figure 2 shows the structure of a thermosetting polymer.

Figure 2

Thermosetting polymer



How can you tell from **Figure 2** that the polymer is thermosetting?

.....

.....

(1)

(Total 6 marks)

24

Water in Britain is taken from reservoirs to use as drinking water.



© KatieJonesPhotography/iStock/Thinkstock

- (a) What are the **two** main steps used to treat water from reservoirs?

Give **one** reason for each step.

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(4)

- (b) Some people use water filters to treat water before drinking it.

- (i) Water filters remove hardness from hard water.

What is in water filters that removes hardness from water?

.....

.....

(1)

- (ii) Suggest why water filters used in the home contain particles of silver.

.....

(1)

- (c) Pure water can be produced by distillation.

Why is distillation **not** usually an economic method of treating water for drinking?

.....

(1)

- (d) Drinking hard water has health benefits.

State **one** health benefit of drinking hard water.

.....

(1)

(Total 8 marks)

25

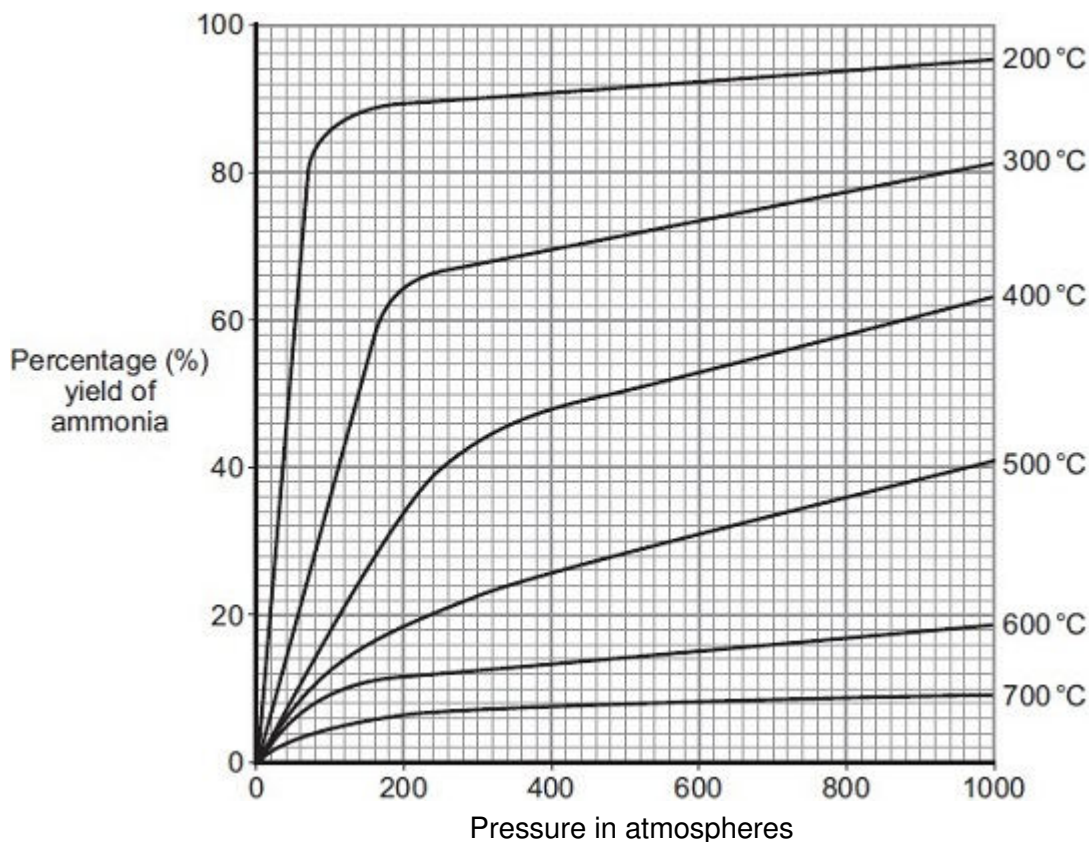
In 1909 Fritz Haber invented a process to produce ammonia from nitrogen and hydrogen.

- (a) Complete and balance the chemical equation for the production of ammonia from nitrogen and hydrogen.



(2)

- (b) The figure below shows how the equilibrium yield of ammonia changes with pressure at different temperatures.



- (i) Use the information in given in the figure to complete the sentence.

The temperature on the graph that gives the highest yield of ammonia is
°C.

(1)

- (ii) The temperature used in the Haber process for the production of ammonia is 450 °C.

Why is a temperature much lower than 450 °C **not** used for the Haber process?

.....
.....

(1)

- (iii) Use the information in the figure to answer this question.

Draw a ring around the pressure that gives the highest yield of ammonia.

100 200 300 400

(1)

- (iv) The pressure used in the Haber process for the production of ammonia is 200 atmospheres.

Why is a pressure lower than 200 atmospheres **not** used for the Haber process?

.....

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(1)

- (c) Explain how ammonia is separated from unreacted nitrogen and hydrogen in the Haber process.

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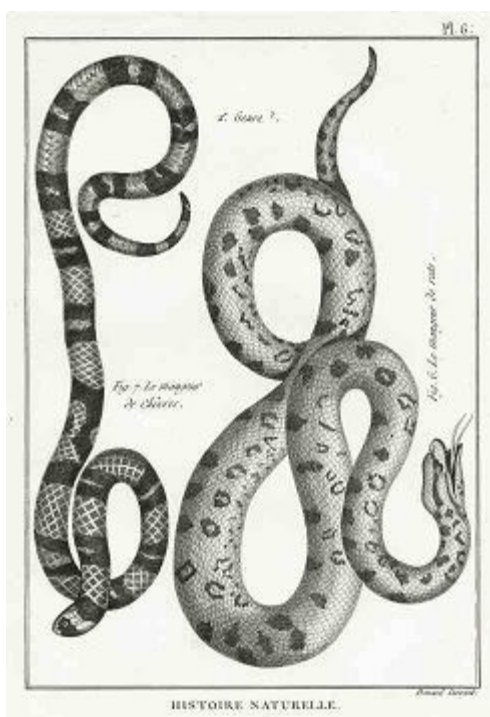
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(2)

(Total 8 marks)

26

Printed pictures can be made using etchings.



© Eduardo Jose Bernardino/iStock

An etching can be made when a sheet of brass reacts with iron chloride solution.

- (a) Brass is a mixture of two metals, copper and zinc.

- (i) A mixture of two metals is called

(1)

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

Copper and zinc atoms are different sizes.

This makes brass

harder
more flexible
softer

than the pure metals.

(1)

- (b) Iron chloride has the formula FeCl_3

Relative atomic masses (A_r): Cl = 35.5; Fe = 56.

- (i) Calculate the relative formula mass (M_r) of iron chloride (FeCl_3).

.....

Relative formula mass (M_r) of iron chloride =

(2)

- (ii) Calculate the percentage of iron in iron chloride (FeCl_3).

.....

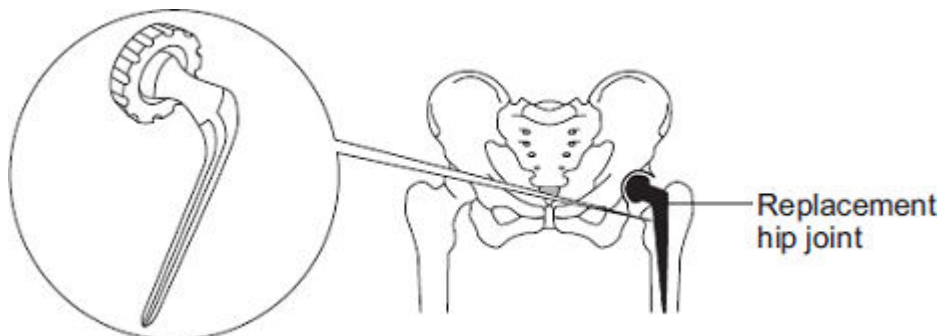
Percentage of iron in iron chloride =%

(2)

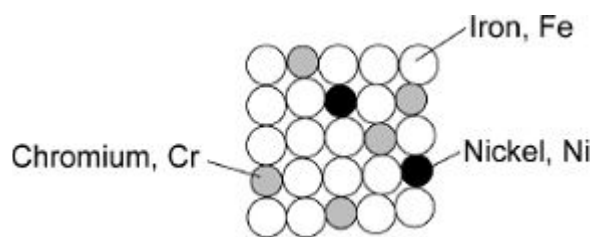
(Total 6 marks)

27

The hip joint sometimes has to be replaced.
Early replacement hip joints were made from stainless steel.



Stainless steel is an alloy of iron, chromium and nickel.
The diagram below represents the particles in stainless steel.



Particle diagram of stainless steel

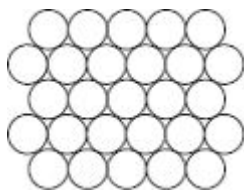
- (a) Use the diagram to complete the percentages of metals in this stainless steel.

The first one has been done for you.

Element	Percentage (%)
Iron, Fe	72
Chromium, Cr	
Nickel, Ni	

(2)

- (b) Pure iron is a soft, metallic *element*.



- (i) Why is iron described as an *element*?

.....

(1)

- (ii) Pure iron would **not** be suitable for a replacement hip joint.

Suggest why.

.....

.....

(1)

- (iii) The three metals in stainless steel have different sized atoms.
Stainless steel is harder than pure iron.

Explain why.

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(2)

(Total 6 marks)

28

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

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

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(2)

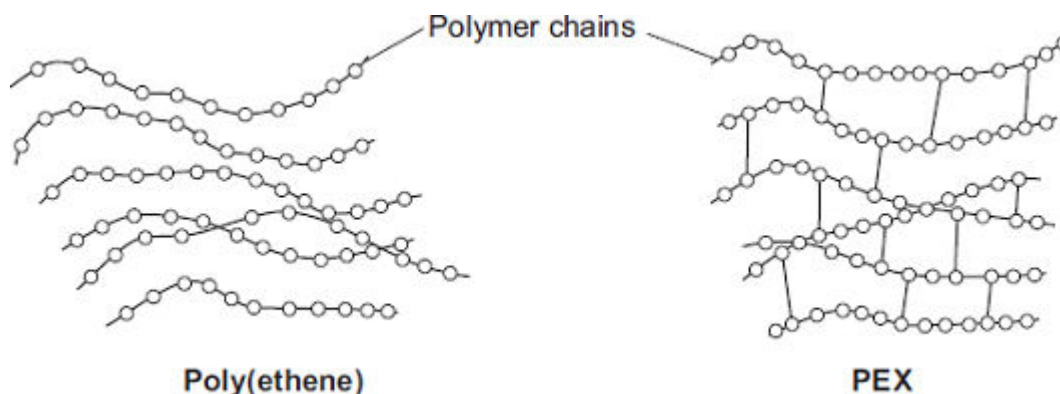
- (ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

.....

.....

(1)

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



Poly(ethene) is a thermoplastic that softens easily when heated.
Suggest and explain how the structure of PEX changes this property.

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(3)

- (b) Copper is a suitable material to use for hot water pipes.
PEX is now used as an alternative material for hot water pipes.

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

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

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

- fractional distillation of crude oil
- cracking of naphtha fraction
- polymerisation of ethene
- conversion of poly(ethene) into PEX.

Use the information above and your knowledge and understanding to suggest possible environmental advantages of using PEX instead of copper for hot water pipes.

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(4)
(Total 10 marks)

Ammonium salts, such as ammonium sulfate, are used to help farmers grow crops.



© Artur Synenko/iStock

- (a) Use the correct word from the box to complete the sentence.

fertilisers

insecticides

pesticides

Ammonium salts contain nitrogen and are used by farmers asto replace the nitrogen lost from the soil.

(1)

- (b) Ammonia is made by reacting nitrogen with hydrogen.

Which raw material provides nitrogen?

Draw a ring around your answer.

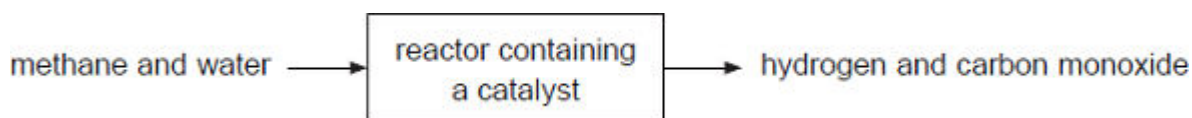
air

crude oil

water

(1)

- (c) Methane and water react together to form hydrogen.

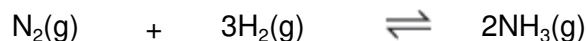


How does the catalyst help this reaction?

.....

(1)

- (d) The reaction between nitrogen and hydrogen to make ammonia can be represented by this equation.



What is the meaning of this symbol \rightleftharpoons ?

Draw a ring around your answer.

endothermic reaction

precipitation reaction

reversible reaction

(1)

- (e) A solution of ammonia in water is alkaline.

- (i) Which **one** of these values could be the pH of a solution of ammonia?

Draw a ring around your answer.

4

7

10

(1)

- (ii) Ammonium sulfate can be made by reacting ammonia solution with sulfuric acid.

Use the correct answer from the box to complete the sentence.

ammonium sulfate

hydrogen

sulfuric

water

During the reaction the hydrogen ions (H^+) from the acid react with hydroxide ions

(OH^-) from the alkali to make

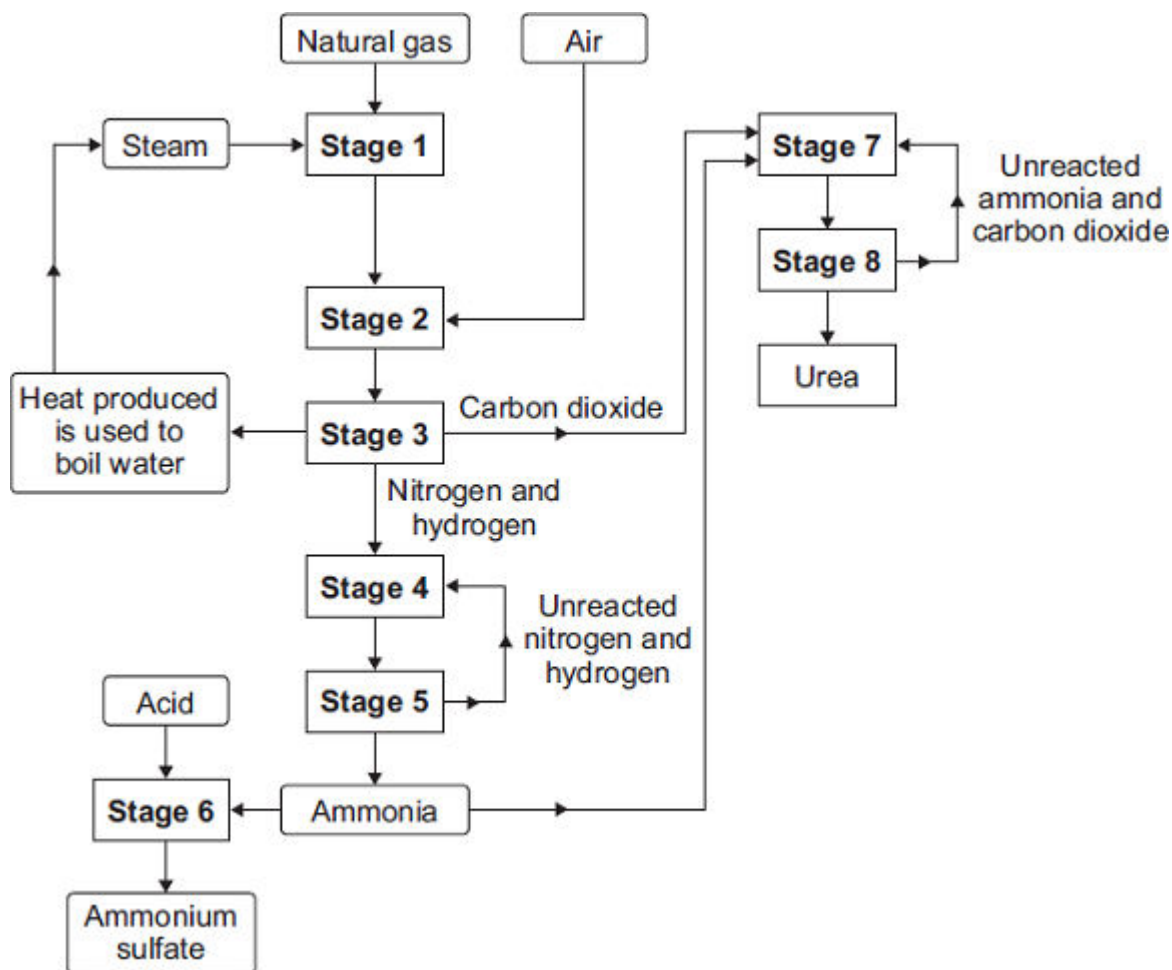
(1)

(Total 6 marks)

30

Ammonium sulfate and urea are made from ammonia. These compounds are used by farmers.

The flow diagram shows the stages to make ammonium sulfate and urea.



- (a) Give **two** examples from the flow diagram of the efficient use of energy and raw materials.

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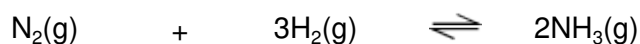
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(2)

- (b) The equation for the reaction in Stage 4 is shown below.



The forward reaction is exothermic.

State **and** explain:

- (i) how a **decrease** in temperature would affect the yield of ammonia at equilibrium

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(2)

- (ii) how an **increase** in pressure would affect the yield of ammonia at equilibrium.

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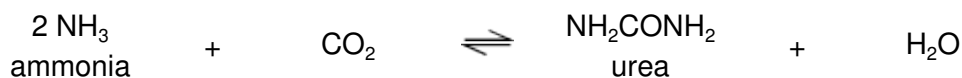
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(2)

- (c) The equation for the reaction in Stage 7 is shown below.



The table gives the relative formula masses (M_r) of the reactants and the products for this reaction.

Formula of reactant or product	Relative formula masses (M_r)
NH_3	17
CO_2	44
NH_2CONH_2	60
H_2O	18

Percentage atom economy can be calculated using:

$$\text{Percentage atom economy} = \frac{M_r \text{ of useful product}}{\text{total } M_r \text{ of all reactants added together}} \times 100\%$$

Calculate the percentage atom economy for the reaction in Stage 7.

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.....

Percentage atom economy = %

(2)
(Total 8 marks)

31

Poly(ethene) is a polymer with many uses.

- (a) Poly(ethene) is not biodegradable.

Give **one** problem caused by waste poly(ethene).

.....

(1)

(b) Many molecules of ethene are combined to make poly(ethene). Ethene is an alkene.

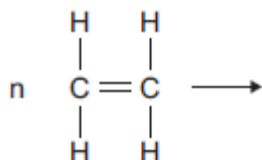
(i) Complete the sentence about the colour change in the test for alkenes.

Alkenes turn bromine water from to

.....

(2)

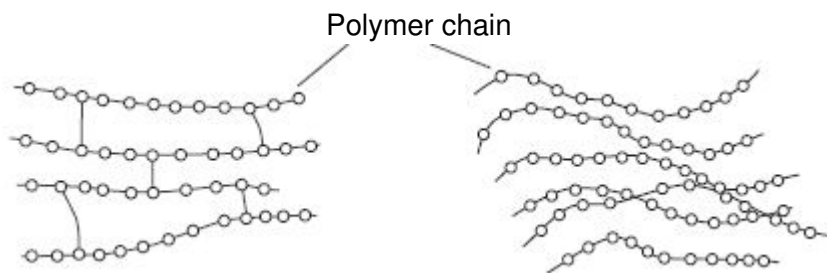
(ii) Complete the equation below to show the formation of poly(ethene).



(3)

(c) Poly(ethene) is a thermosoftening polymer that melts when heated.

The diagrams show a thermosetting polymer and a thermosoftening polymer.



Thermosetting polymer

Thermosoftening polymer

The thermosetting polymer does **not** melt when heated.

Use the diagrams and your knowledge of structure and bonding to explain why.

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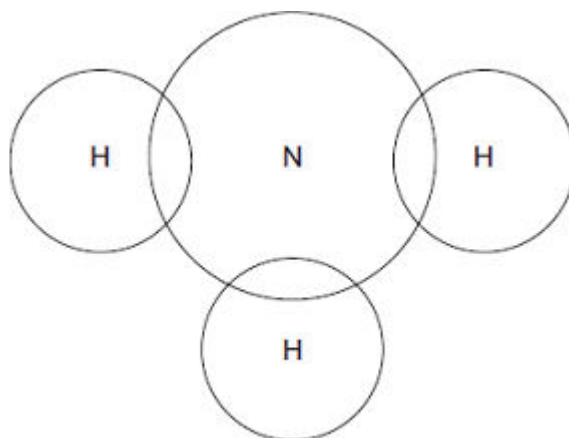
(3)

(Total 9 marks)

32

- (a) Complete the dot and cross diagram to show the electrons in the outer energy levels of ammonia (NH_3).

You may use the periodic table to help you.

**(2)**

- (b) Ammonia can be used to make ammonium nitrate (NH_4NO_3).

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

Ammonium nitrate can be made by reacting ammonia with

ethanoic
hydrochloric
nitric

acid.

(1)

- (ii) State **one** use of ammonium nitrate.

.....

(1)

- (iii) Calculate the relative formula mass (M_r) of ammonium nitrate (NH_4NO_3).

Relative atomic masses: $\text{H} = 1$; $\text{N} = 14$; $\text{O} = 16$.

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.....

Relative formula mass (M_r) =

(2)

- (iv) Calculate the percentage by mass of nitrogen in ammonium nitrate.

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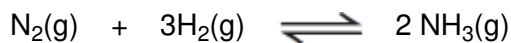
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Percentage by mass of nitrogen = %

(2)

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

Ammonia is manufactured from nitrogen and hydrogen by the Haber process:



The forward reaction is exothermic.

The conditions used in the Haber process are:

- 200 atmospheres pressure
- 450 °C
- iron catalyst.

Use the equation and your knowledge of reversible reactions to explain why these conditions are used in the Haber process.

To get full marks you must consider **both** yield **and** rate of reaction in your answer.

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(6)
(Total 14 marks)

33

Most water contains dissolved compounds.

The concentrations of these dissolved compounds are higher in sea water than in drinking water.

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

Pure water can be obtained from sea water by

distillation. filtration. neutralisation.

(1)

- (ii) What is the boiling point of pure water? °C

(1)

- (b) A student wanted to find out how much solid was dissolved in sea water.

This is the method the student used:

- measure the mass of an empty evaporating basin
- measure 25 cm³ of sea water and pour it into the evaporating basin
- heat the evaporating basin gently until all of the water has evaporated
- measure the mass of the evaporating basin containing the solid residue.

- (i) What piece of apparatus would be suitable for measuring 25 cm³ of sea water?

.....

(1)

- (ii) How could the student check that all of the water had evaporated?

.....

.....

.....

.....

(2)

- (iii) The results the student obtained using 25 cm³ of sea water are:

mass of empty evaporating basin = 23.21 g

mass of evaporating basin and dry solid residue = 24.04 g

Calculate the mass of solid dissolved in 1000 cm³ of the sea water.

.....

.....

.....

Mass dissolved in 1000 cm³ = g

(2)

- (c) In many countries chlorine is added to drinking water supplies.

Why is chlorine added to drinking water?

.....

.....

(1)

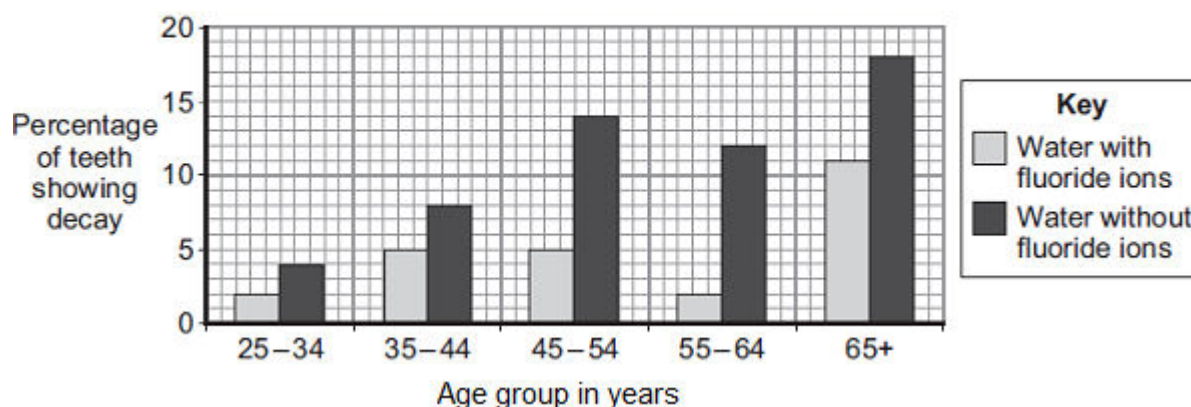
- (d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

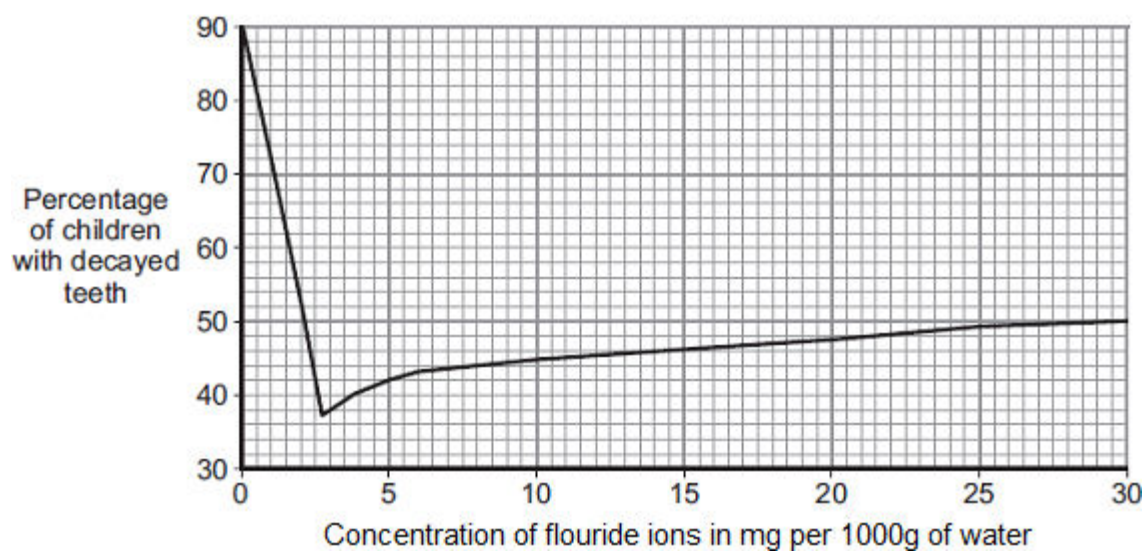
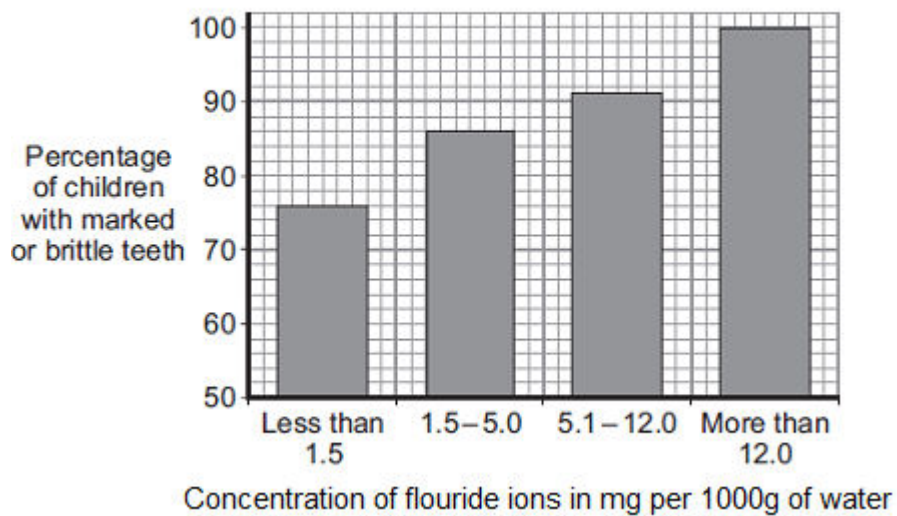
Compounds containing fluoride ions are added to some drinking water supplies.

Many scientists have done research into the effects of fluoride ions in drinking water.

Graphs 1, 2 and 3 show some of the results obtained.

Graph 1



Graph 2**Graph 3**

Evaluate the advantages and disadvantages of adding fluoride ions to drinking water.

You should support your answer with evidence from **all three** graphs.

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(6)
(Total 14 marks)

34

Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

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

Suggest **two** reasons why.

.....

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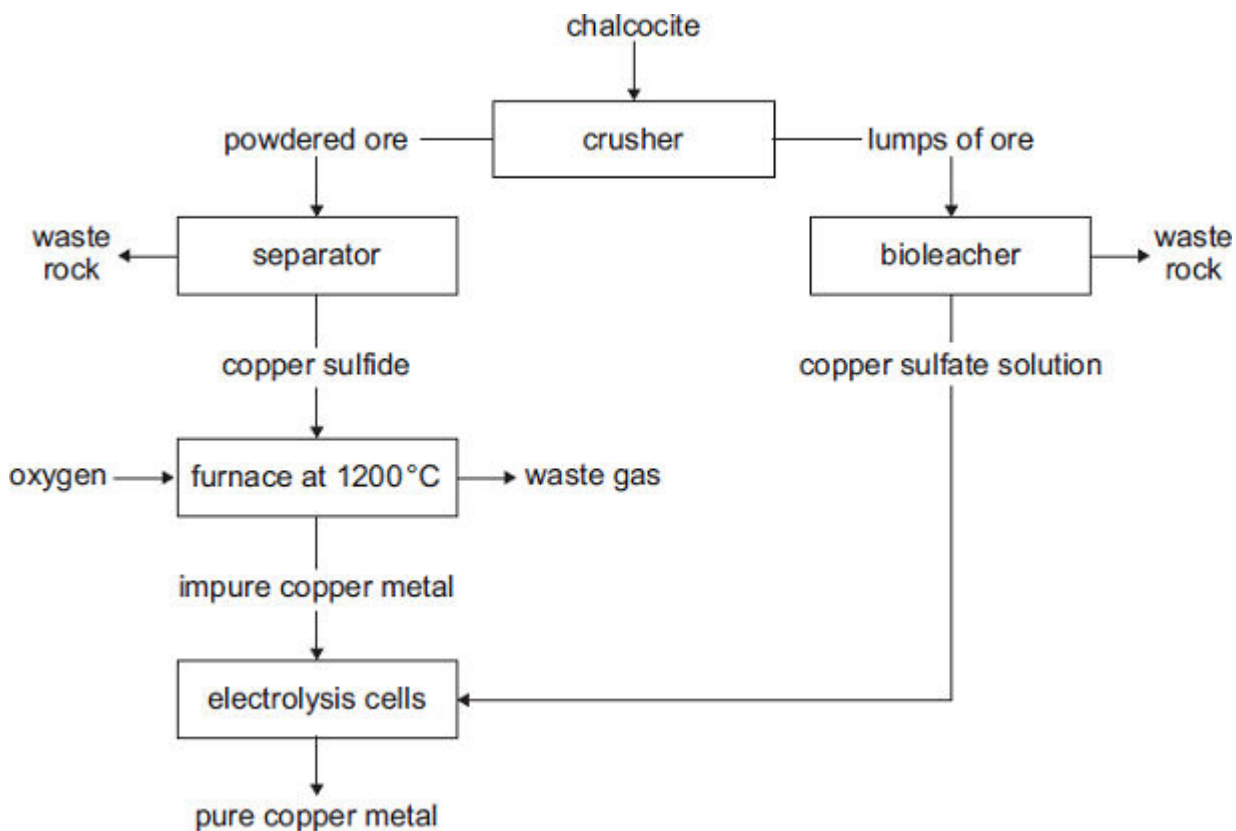
.....

.....

(2)

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

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



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

.....

(1)

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

.....

(2)

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

.....

(1)

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

Which electrode do the copper ions move towards?

Give a reason for your answer.

.....

.....

.....

.....

(2)

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

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

.....

.....

(1)

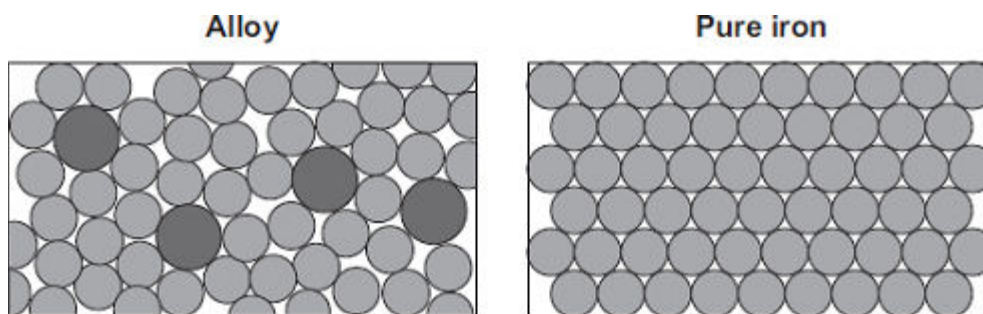
(Total 9 marks)



© Digital Vision/Photodisc

- (a) Drills are made from an alloy of iron.

The diagrams show the particles in the alloy and in pure iron.



Use the diagrams to explain why the alloy is harder than pure iron.

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(2)

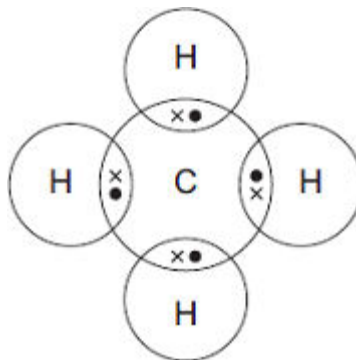
- (b) Drill heads contain diamonds.

Tick (✓) **two** reasons why diamonds are hard.

Reason	Tick (✓)
Diamonds have a giant covalent structure.	
Diamonds have high melting points.	
Diamonds are unreactive.	
Diamonds have strong bonds between carbon atoms.	

(2)

- (c) Methane gas is often found where crude oil is found.
The diagram shows how atoms bond in methane.
Only the outer electrons are shown.



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

Methane is

a compound.
an element.
a mixture.

(1)

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

The formula of methane is

C_4H_4
 C_4H
 CH_4

(1)

- (iii) Name the type of bond between the carbon and hydrogen atoms in methane.

.....

(1)

- (d) Explain why methane is a gas at 20°C.

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

(2)

(Total 9 marks)



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

Explain why alloys are harder than pure metals.

.....

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.....

(3)

- (b) Drill heads also contain diamonds.

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

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(4)

- (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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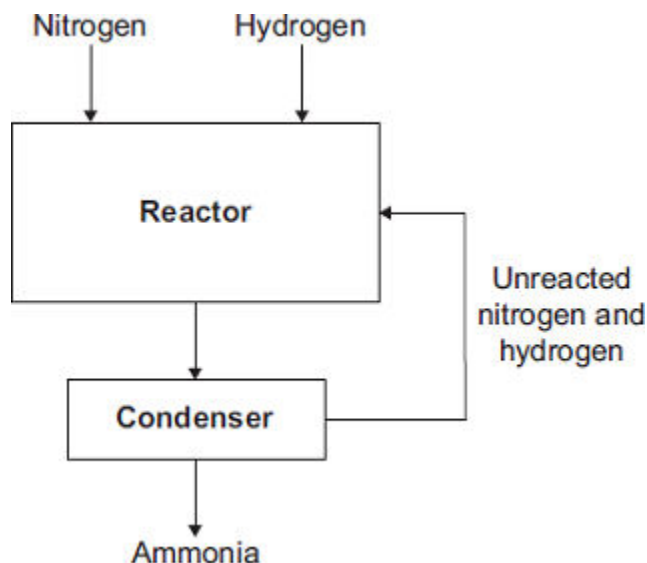
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(4)
(Total 11 marks)

37

The flow diagram shows the Haber process. In the Haber process ammonia is produced from nitrogen and hydrogen.



- (a) The word equation for the production of ammonia is:



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

The symbol \rightleftharpoons in the word equation shows the reaction is

exothermic.
reversible.
slow.

(1)

- (b) The reactor contains iron.

Complete the sentence.

The iron speeds up the reaction because it is a

(1)

- (c) What happens to the unreacted nitrogen and hydrogen?

.....

.....

(1)

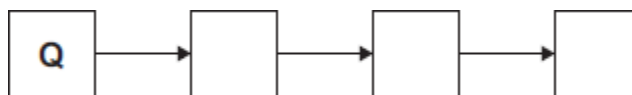
- (d) The sentences describe how ammonia is produced in the Haber process.

The sentences are in the wrong order.

- P** Ammonia is separated as a liquid.
Q Nitrogen and hydrogen are mixed together.
R A mixture of gases enters the condenser.
S Nitrogen and hydrogen react to produce ammonia.

Complete the boxes below to show the correct order of the sentences.

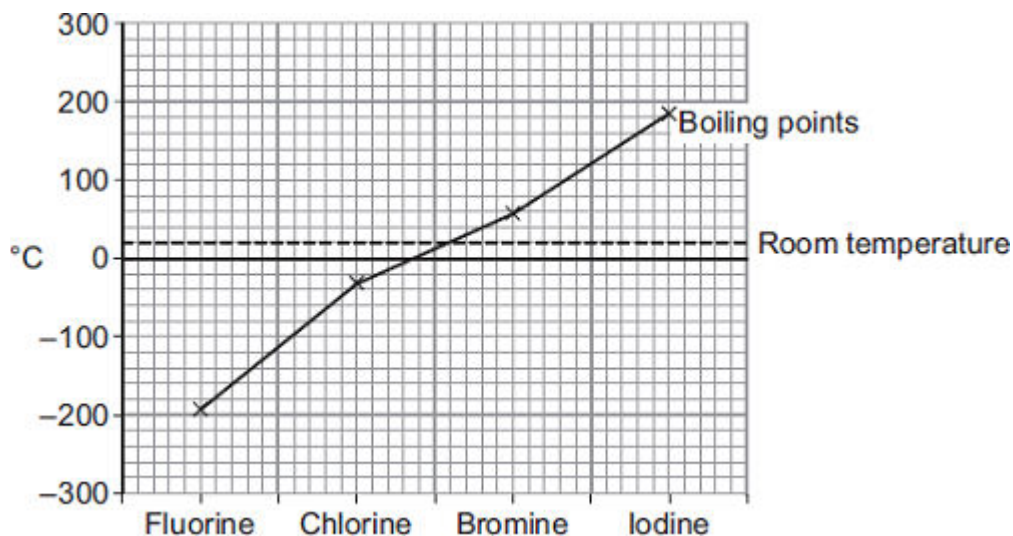
The first box has been done for you.



(2)
(Total 5 marks)

38

The graph shows the boiling points of the halogens.



- (a) Use the graph to help you answer these questions.

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

gas	liquid	solid
-----	--------	-------

At room temperature chlorine is a

(1)

- (ii) Describe the trend in boiling point from fluorine to iodine.

.....

(1)

(b) Chlorine reacts with metals to produce metal chlorides.

(i) When a chlorine atom forms a chloride ion it gains one electron.

What is the charge on a chloride ion?

.....

(1)

(ii) Write a word equation for the reaction between sodium and chlorine.

.....

(1)

(c) In the UK water companies add chlorine to tap water.

Why is chlorine added to tap water?

.....

(1)

(d) Water companies add fluoride to tap water in some parts of the UK.

Fluoride is added to improve dental health.

Suggest **one** reason why some people are against adding fluoride to tap water.

.....

.....

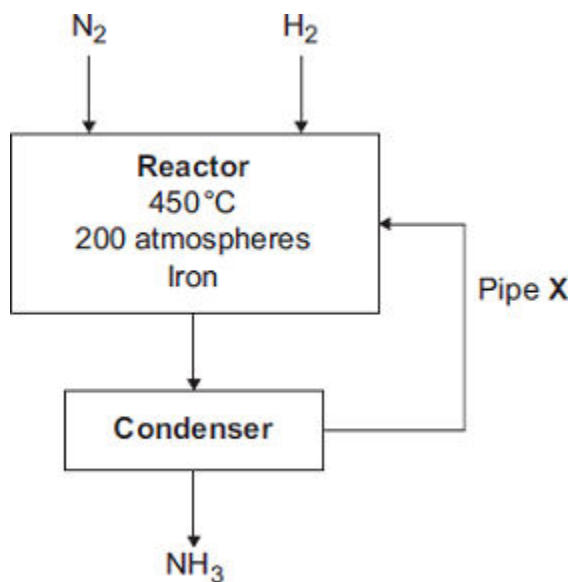
.....

(1)

(Total 6 marks)

39

The flow diagram shows the Haber process. In the Haber process, ammonia (NH_3) is produced from nitrogen (N_2) and hydrogen (H_2).



- (a) Which raw material is nitrogen obtained from?

.....

(1)

- (b) What is the purpose of Pipe X?

.....

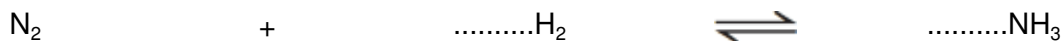
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.....

(2)

- (c) Balance the chemical equation below for the production of ammonia.



(1)

- (d) A temperature of 450°C is used in the reactor.
The reaction of nitrogen with hydrogen is reversible.
The forward reaction is exothermic.

Explain why a temperature of 450°C is the optimum temperature for the Haber process.

.....

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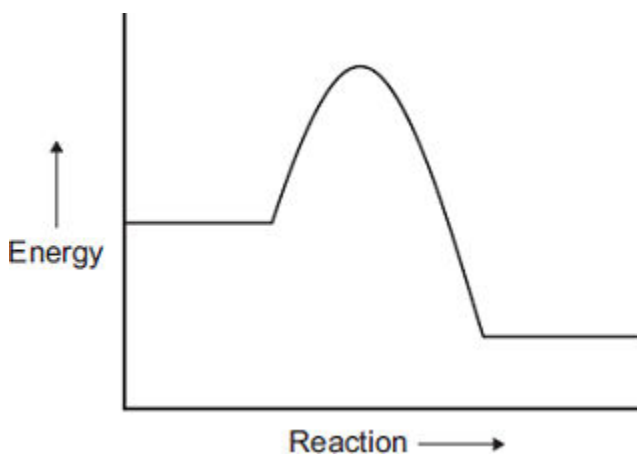
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(2)

- (e) An energy level diagram for the reaction between nitrogen and hydrogen is shown below.



- (i) How does the energy level diagram show this reaction is exothermic?

.....

.....

(1)

- (ii) In the Haber process iron is used as a catalyst.

Draw a line on the energy level diagram to show the effect of adding a catalyst.

(1)

(Total 8 marks)

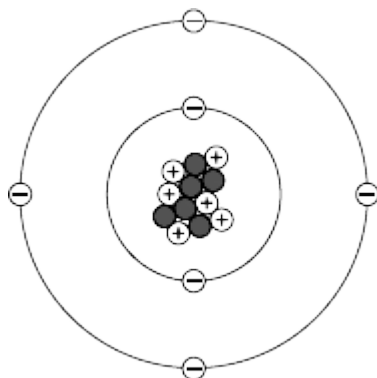
40

The picture shows a diamond ring.



Photograph supplied by Comstock/Thinkstock

- (a) Diamond is a form of carbon. The diagram represents a carbon atom.



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

Name of particle	Charge
proton	
neutron	0
	-1

(2)

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

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

Gold and carbon are

compounds.
elements.
mixtures.

(1)

(ii) Complete the sentence.

Gold and carbon have different properties because gold is a metal
and carbon is a

(1)

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

Pure gold is not used to make the ring because pure gold is too

hard.
reactive.
soft.

The gold ring is made by mixing pure gold with other metals to form

a compound.
an atom.
an alloy.

(2)

- (d) The data in the table shows some information about the three metals in the gold ring.

Name of metal	Atomic number	Percentage (%) of metal
gold	79	
silver	47	16
copper	29	9

Draw **one** line from each question to its correct answer.

Question	Answer
What is the percentage of gold in this ring?	29
How many electrons are there in a copper atom?	61
How many neutrons are in an atom of silver with a mass number of 108?	75
	79

(3)
(Total 9 marks)

41

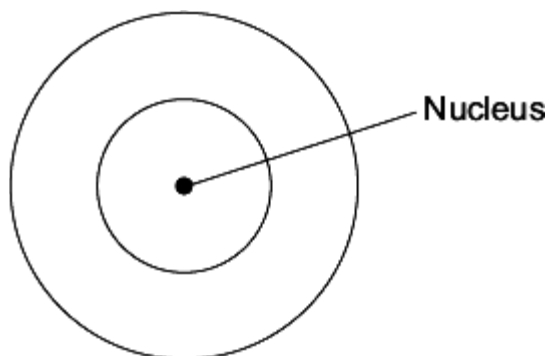
The picture shows a diamond ring.



Photograph supplied by Comstock/Thinkstock

- (a) Diamond is a form of carbon. A carbon atom has six electrons.

Draw the electronic structure of a carbon atom.



(1)

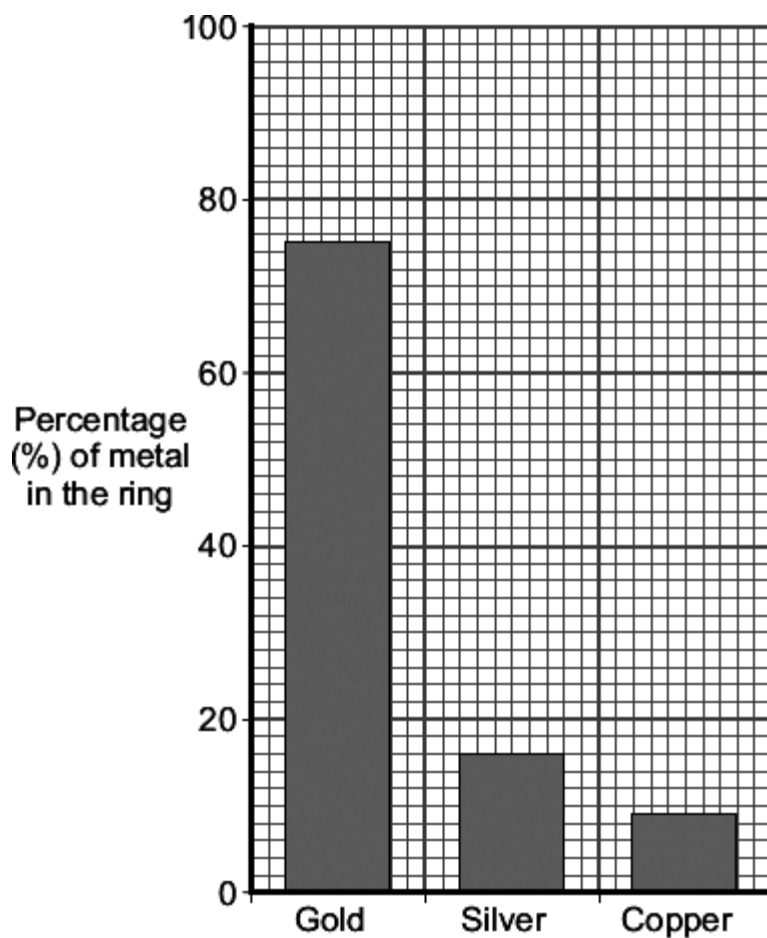
- (b) A gold atom has an atomic number of 79 and a mass number of 197.

Complete the table to show the name and number of each sub-atomic particle in this gold atom.

Name	Number
Proton	79
Electron
.....

(3)

- (c) The bar chart shows the composition of this gold ring.



- (i) Give the percentage of the other two metals in this gold ring.

Silver is % and copper is %

(1)

- (ii) This gold ring is not made from 100% gold.

Give **two** reasons why.

1

.....

.....

2

.....

.....

(2)

(Total 7 marks)

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



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

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

(i) Name this type of reaction.

.....

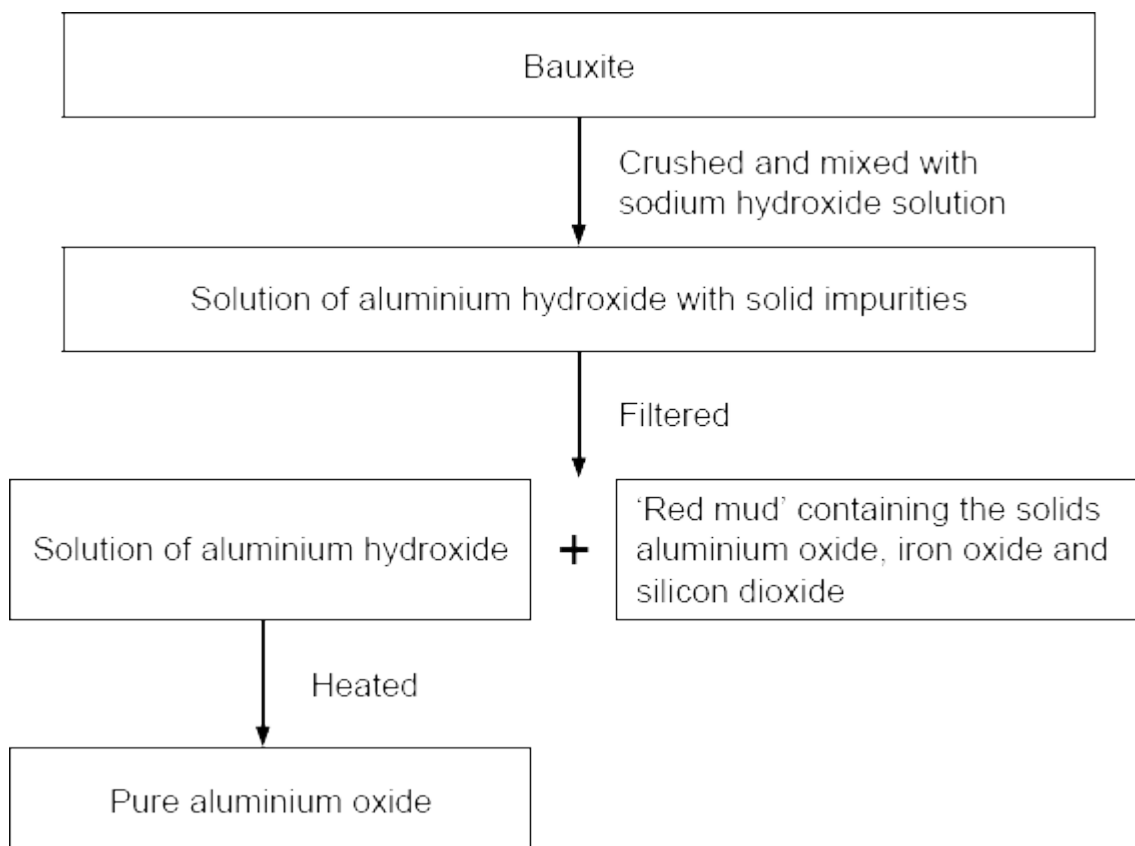
(1)

(ii) Balance the symbol equation for this reaction.



(1)

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



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

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

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

What percentage of aluminium oxide did the bauxite contain?

.....

Answer = %

(1)

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

.....

(1)

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

Suggest **one** reason why.

.....

(1)

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

During one year in the USA:

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

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

Environmental

.....

Ethical or social

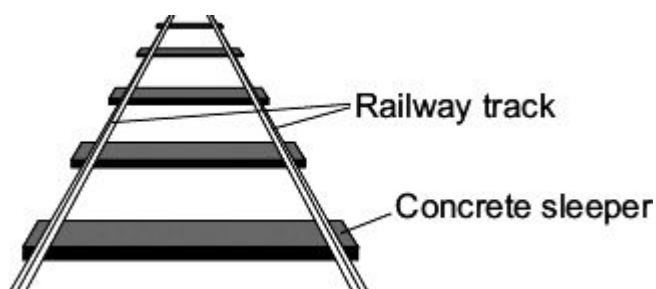
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(2)

(Total 7 marks)

43

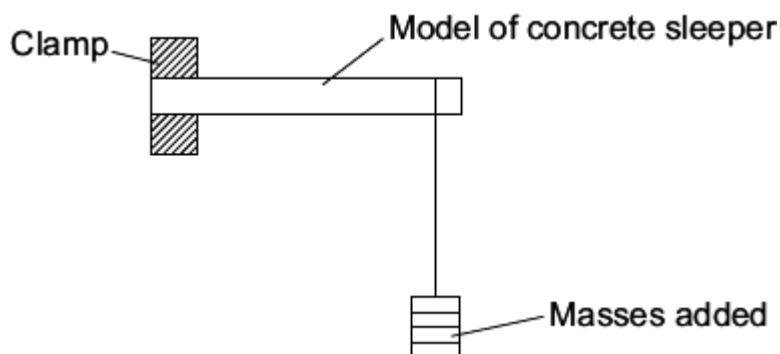
In the UK, railway sleepers are often made from concrete.



A scientist was asked to find the best concrete mixture to use so that railway sleepers would not break easily.

The scientist made:

- a mould to make small models of concrete sleepers
- concrete mixtures using crushed rock, sand, cement and water
- the equipment shown to add 0.1 kg masses until the model sleeper broke.



The scientist's results are shown in the table.

Concrete mixture in % by volume			Total mass added to break the model sleeper in kg			
Cement	Sand	Crushed rock	Test 1	Test 2	Test 3	Mean
10	70	20	1.1	1.3	1.2	1.2
20	60	20	2.6	2.5	2.4	
30	50	20	3.3	3.3	3.3	3.3
40	40	20	3.8	4.0	3.3	3.9
50	30	20	4.5	4.2	4.3	4.3

- (a) (i) Calculate the mean total mass added to break the model sleeper that has 20%

cement by volume.

.....

Mean = kg

(1)

- (ii) Choose **one** result in the table that the scientist should check and test again.

Result: % cement by volume Test number

Explain why you chose this result.

.....

.....

(2)

- (iii) What is the relationship between the total mass to break the model sleeper and the percentage (%) of cement by volume in the concrete mixture?

.....

.....

(1)

- (iv) Suggest **one** other variable that the scientist should have recorded in the table of results.

.....

(1)

- (b) The scientist thought that full-size railway sleepers should be made from 30% cement, 50% sand and 20% crushed rock.

What other information about these three materials is needed before the scientist recommends using this mixture to make a full-size railway sleeper?

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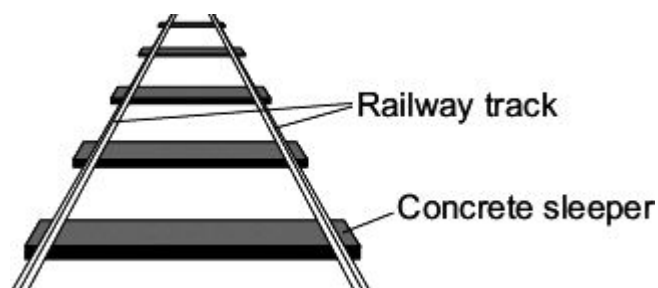
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(2)

(Total 7 marks)

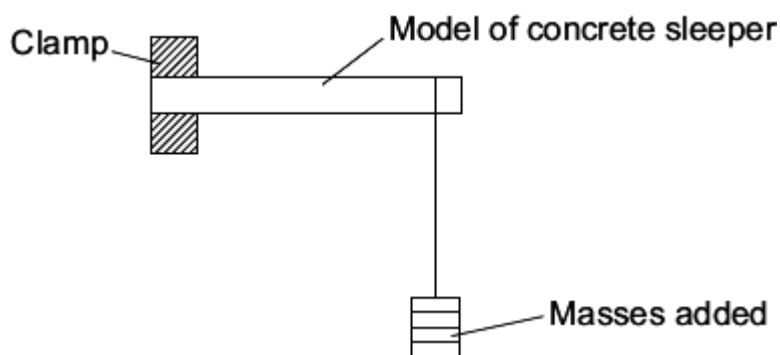
44

In the UK, railway sleepers were made from wood. They are now often made from concrete.



A scientist was asked to find the best concrete mixture to use so that railway sleepers would not break easily. The scientist made:

- a mould to make small models of concrete sleepers
- concrete mixtures using crushed rock, sand, cement and water
- the equipment shown to add 0.1 kg masses until the model sleeper broke.



The scientist's results are shown in the table.

Concrete mixture in % by volume			Total mass added to break the model sleeper in kg				
Cement	Sand	Crushed rock	Test 1	Test 2	Test 3	Test 4	Mean
10	70	20	1.2	1.1	1.3	1.2	1.2
20	60	20	3.0	2.6	2.5	2.4	
30	50	20	3.5	3.3	3.3	3.3	3.3
40	40	20	3.9	3.8	4.0	3.3	3.9
50	30	20	4.2	4.5	4.2	4.3	4.3

- (a) Calculate the mean total mass added to break the model sleeper that has 20 % cement by volume.

.....

.....
Mean = kg

(2)

- (b) State **one** conclusion that the scientist could make from these results.

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

(1)

- (c) The scientist sent the results in a report to a company that makes full-size concrete railway sleepers.

- (i) Suggest **two** other factors that the company should take into consideration before deciding which mixture to use to make a full-size concrete railway sleeper.

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

(2)

- (ii) The scientist's report claimed that using concrete sleepers instead of wooden sleepers would have less environmental impact.
Do you agree with the scientist's claim?
Use your knowledge and understanding to justify your answer.
Remember to compare using concrete with using wood for the sleepers.

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.....

(4)
(Total 9 marks)

45

- (a) Ammonia solution is used in cleaning products to remove grease from kitchen surfaces.



Ammonia solution is alkaline.

- (i) Draw a ring around the number most likely to be the pH of ammonia solution.

1 3 7 10

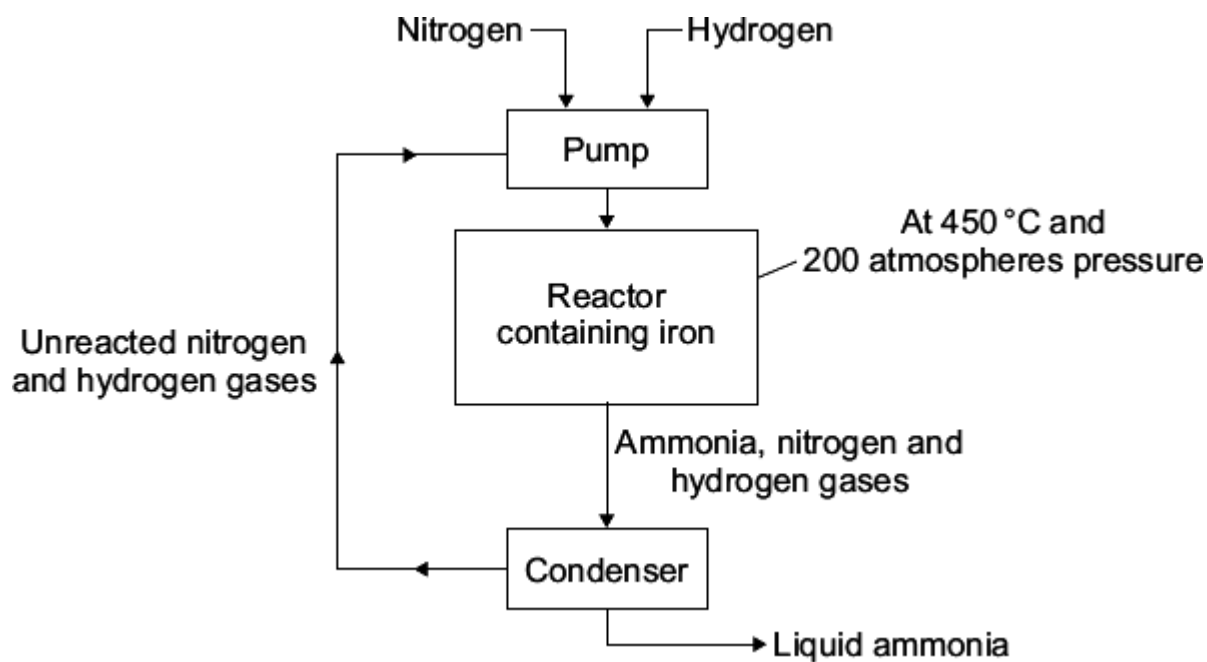
(1)

(ii) Draw a ring around the ion in ammonia solution which makes it alkaline.

Cl⁻**H⁺****Na⁺****OH⁻**

(1)

(b) Ammonia is made using the Haber process.



(i) Where does the nitrogen used in the Haber process come from?

Draw a ring around your answer.

air**natural gas****water**

(1)

- (ii) A high temperature of 450 °C is used in the reactor.

Tick (✓) **two** reasons in the table which explain why high temperatures make reactions faster.

Reasons	Tick (✓)
Particles move faster	
Particles are closer together	
Particles collide more often	
Particles have less energy	

(2)

- (iii) The iron in the reactor speeds up the reaction but is not used up.

What is the name given to substances that speed up the chemical reaction but which are not used up during the reaction?

.....

(1)

- (c) Complete the sentence.

The condenser separates the ammonia from the unreacted nitrogen and hydrogen by turning the ammonia into a

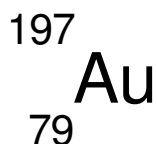
(1)

(Total 7 marks)

46

Gold and gold ions are used as catalysts.

- (a) An atom of gold is represented as:



Complete the sentences.

The atomic number of gold is

The number of electrons in an atom of gold is

(2)

- (b) Scientists have found that gold nanoparticles are very good catalysts.

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

A gold nanoparticle contains a few

hundred
thousand
million

atoms.

(1)

- (c) The formation of a gold ion (
- Au^{3+}
-) from a gold atom (
- Au
-) is shown in the symbol equation.



- (i) Complete the sentence.

The particles lost when a gold atom becomes a gold ion
are called

(1)

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

The number of these particles lost when a gold atom becomes a gold ion is

one.
two.
three.

(1)

- (d) Gold ions are used as a catalyst in the reaction to make chloroethene.

How does a catalyst help a reaction?

.....

(1)

- (e) Chloroethene can react to make a thermosoftening polymer.

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

When heated, a thermosoftening polymer will

dissolve.

melt.

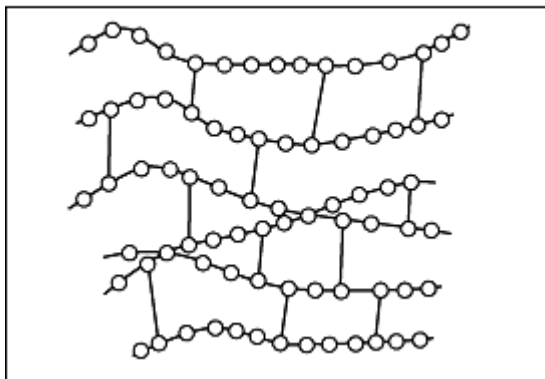
solidify.

(1)

- (ii) Polymer **B** is a different type of polymer.

The diagram shows the structure of polymer **B**.

Polymer B



How can you tell from the diagram that polymer **B** is **not** thermosoftening?

.....

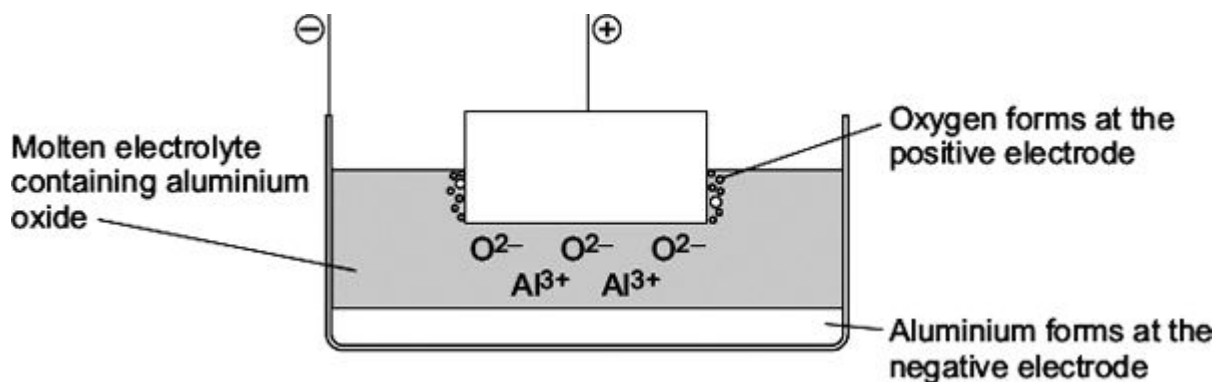
.....

(1)

(Total 8 marks)

47

The diagram represents an electrolysis cell for extracting aluminium.
The current will only flow when the electrolyte is molten.



(a) The electrolyte is aluminium oxide mixed with another substance.

(i) What is the name of the other substance in the electrolyte?

Draw a ring around the correct answer.

cryolite

rock salt

limestone

(1)

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

This other substance is added to

condense the aluminium oxide.

lower the melting point of the aluminium oxide.

raise the boiling point of the aluminium oxide.

(1)

(b) (i) Oxide ions (O^{2-}) move to the positive electrode.

Explain why.

.....

.....

.....

.....

(2)

- (ii) Oxygen is formed at the positive electrode. The oxygen then forms carbon dioxide.

The equation for the reaction is shown below.



Complete the sentence.

The name of the element which reacts with oxygen is

(1)

- (iii) The positive electrode gets smaller.

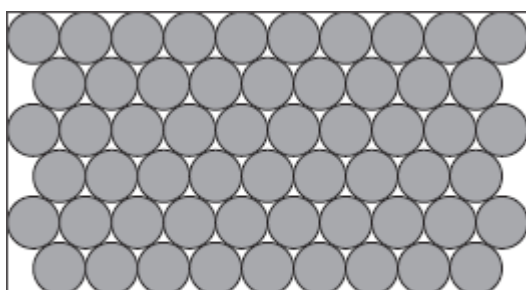
Suggest why.

.....

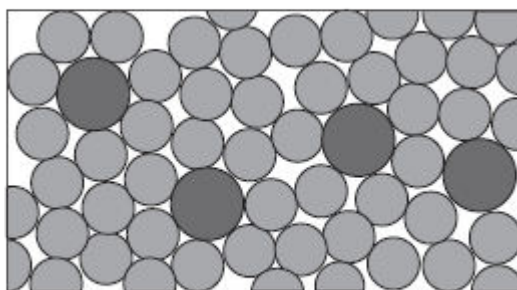
(1)

- (c) Aluminium is used in an alloy with magnesium to make drinks cans.

The diagrams show the arrangement of atoms in pure aluminium and in the alloy.



Pure aluminium



Alloy

The alloy is harder than pure aluminium.

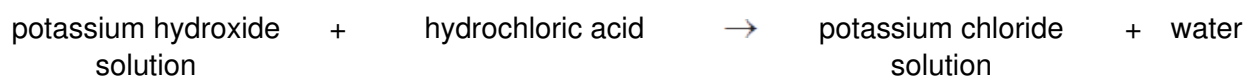
Explain why. Use the diagrams to help you.

.....

(2)

(Total 8 marks)

The salt called potassium chloride is made when potassium hydroxide solution reacts with hydrochloric acid.



Describe a method for making **crystals** of potassium chloride from potassium hydroxide solution and hydrochloric acid.

In this method you should:

- describe how you will add the correct amount of the hydrochloric acid to neutralise the potassium hydroxide solution
- describe how you will get crystals of potassium chloride.

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(6)

- (b) Ammonium nitrate is another salt.
Ammonium nitrate is made when ammonia solution is neutralised with an acid.

Name the acid to complete the word equation.

ammonia + acid \rightarrow ammonium nitrate

(1)

- (c) Read the information.

Ammonium nitrate – good or bad?

Some farmers put a lot of ammonium nitrate on their farmland.

Many people are worried about this use of ammonium nitrate.

Rain water can wash the ammonium nitrate off the farmland and into rivers and lakes. The ammonium nitrate may get into drinking water supplies and could be harmful to health.

- (i) Why do some farmers put ammonium nitrate on their farmland?

.....
.....

(1)

- (ii) Which **one** of the questions in the table cannot be answered by science alone?

Tick (✓) **one** question.

Question	Tick (✓)
How much ammonium nitrate is in drinking water?	
Should farmers stop using ammonium nitrate on their farmland?	
Is ammonium nitrate soluble in rain water?	

Give **two** reasons why this question **cannot** be answered by science alone.

.....

.....

.....

.....

(3)
(Total 11 marks)

49

Iron is extracted from its ore.

(a) Iron ore is quarried.



Photograph supplied by Stockbyte/Thinkstock

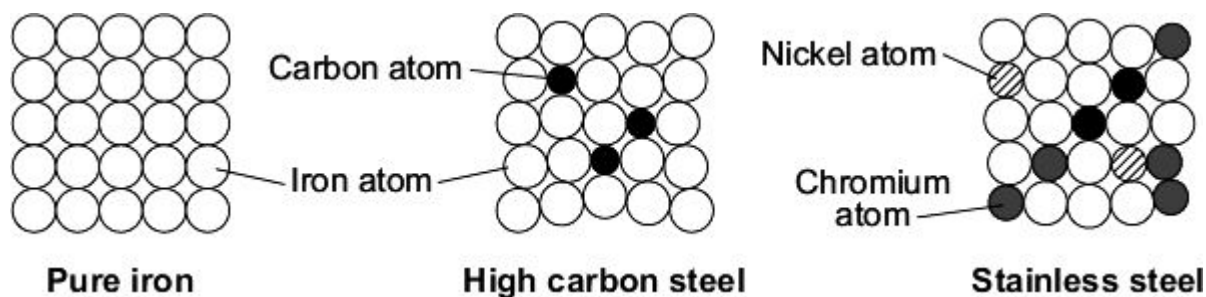
Quarrying iron ore has impacts that cause environmental problems.

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)

50

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

- (a) Iron is extracted from an *ore* that contains about 60% iron oxide, Fe_2O_3

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

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.....

(1)

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

iron oxide + carbon monoxide \rightarrow iron + carbon dioxide

Complete and balance the chemical equation for this reaction.

Fe_2O_3 + CO \rightarrow +

(2)

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

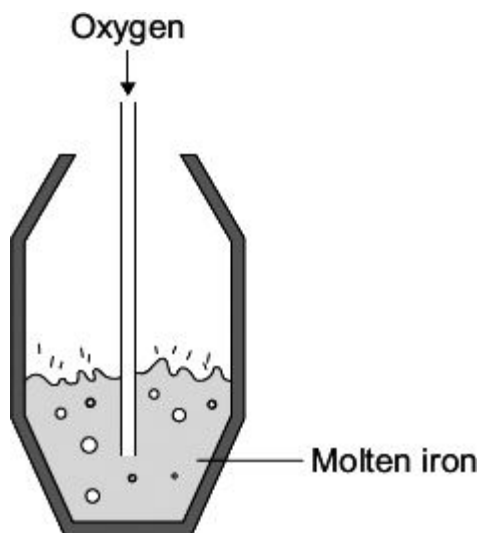
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(1)

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

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

Stage 2 adding other metals to make different steels.



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

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(2)

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

Suggest why different steels are needed.

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(1)

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

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

Explain why.

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(2)
(Total 9 marks)

Supermarkets launch eco-friendly plastic milk bags. Could this be the end of the milk bottle?



Milk bottles are made from glass or from plastic.

Glass milk bottles contain 0.5 litres of milk. When the milk is used up the empty bottles are returned to be re-used. Glass milk bottles are re-used 24 times on average. The glass to make new milk bottles is produced when a mixture of sand, limestone, soda and recycled glass is heated to about 1600 °C in a furnace. There are almost unlimited amounts of the raw materials needed to produce this glass. About 35% of used glass is recycled.

The most common plastic milk bottles contain 2 litres of milk. When the milk is used up the empty bottles are discarded as waste. The plastic used to make these milk bottles is poly(ethene). Poly(ethene) is produced from crude oil by first using fractional distillation, then cracking the naphtha fraction and finally polymerising the ethene. About 5% of used poly(ethene) is recycled.

The new plastic milk bags contain 2 litres of milk. The milk bags are also made from poly(ethene). A milk bag uses 75% less poly(ethene) than is used to make the poly(ethene) milk bottles. When the milk is used up the empty bags are discarded as waste.

- (a) Describe what happens in fractional distillation so that fractions, such as naphtha, are separated from crude oil.

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(3)

- (b) Supermarkets claim that using milk bags instead of milk bottles would have less environmental impact.

Do you agree with this claim?

Use the information in the article and your knowledge and understanding to make appropriate comparisons to justify your answer.

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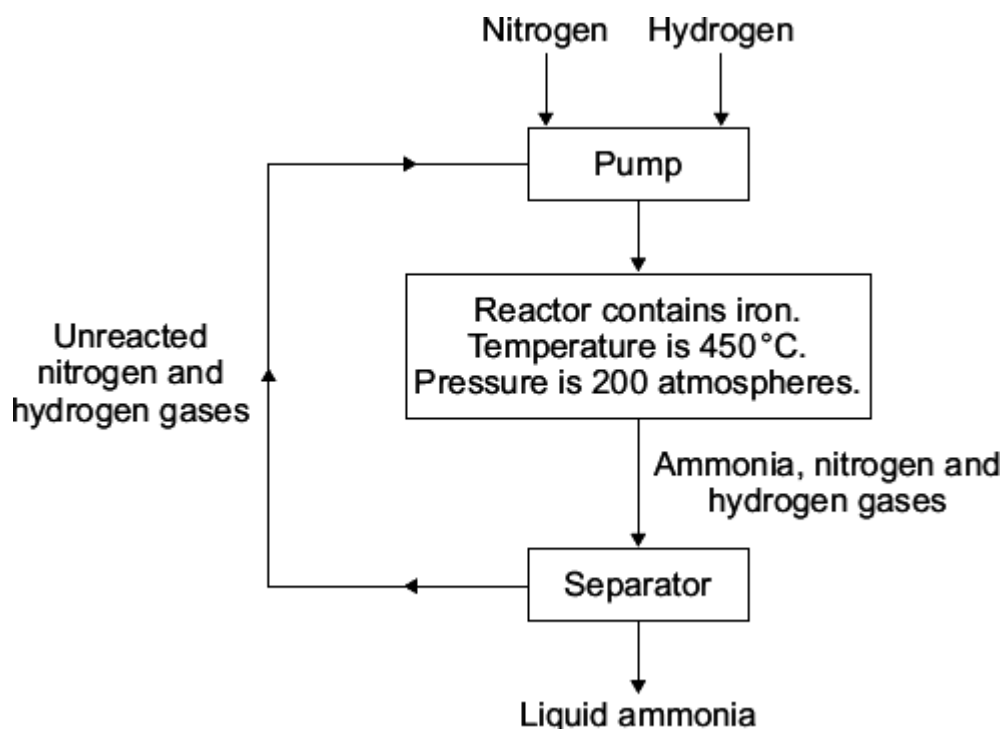
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(4)
(Total 7 marks)



- (a) How is ammonia separated from unreacted nitrogen and hydrogen in the separator?

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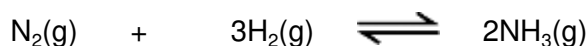
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(2)

- (b) The equation shows the reaction which takes place in the reactor:



- (i) Why does the yield of ammonia at equilibrium increase as the temperature is decreased?

.....

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(1)

- (ii) A temperature of 450 °C is used in the reactor to make the reaction take place quickly.

Explain, in terms of particles, why increasing the temperature makes a reaction go faster.

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(2)

- (iii) Why does the yield of ammonia at equilibrium increase as the pressure is increased?

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(1)

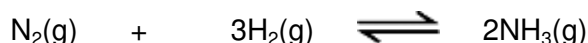
- (iv) The pressure used in the reactor is 200 atmospheres.
Suggest why a much higher pressure is **not** used.

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(1)

- (c) Use the equation for the reaction in the reactor to help you to answer these questions.



- (i) It is important to mix the correct amounts of hydrogen and nitrogen in the reactor.

20 m³ of nitrogen is reacted with hydrogen.

What volume of hydrogen (measured at the same temperature and pressure as the nitrogen) is needed to have the correct number of molecules to react with the nitrogen?

Volume of hydrogen needed = m³

(1)

- (ii) Calculate the maximum mass of ammonia that can be made from 2 g of nitrogen.

Relative atomic masses: H = 1; N = 14.

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Maximum mass of ammonia = g

(3)

- (d) The expected maximum mass of ammonia produced by the Haber process can be calculated.

- (i) In one process, the maximum mass of ammonia should be 80 kg.

The actual mass of ammonia obtained was 12 kg.

Calculate the percentage yield of ammonia in this process.

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.....

Percentage yield of ammonia = %

(1)

- (ii) Give **two** reasons why it does **not** matter that the percentage yield of ammonia is low. Use the flow diagram at the start of this question to help you.

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(2)

(Total 14 marks)

53

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.

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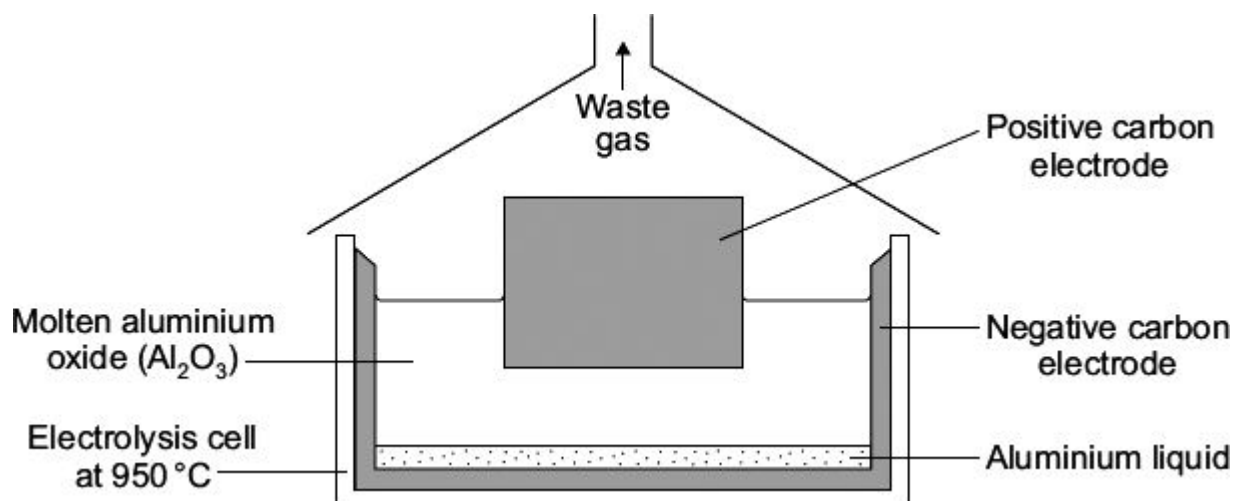
(1)

- (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.

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.....
.....

(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)

Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers. The Government states that this is because plastic bags use up resources that are not renewable and that the manufacture of plastic bags produces carbon dioxide. Most of these plastic bags are made from poly(ethene). The table shows methods to deal with large numbers of used plastic bags.

Method	Description of what happens to the plastic bag
Reused	used again by the customer
Recycled	collected, transported, washed and melted to make new plastic items
Burned	collected, transported and burnt to release heat energy
Dumped	mixed with other household waste, collected, transported and disposed of at a landfill site

Use the information and your knowledge and understanding to briefly give **one advantage and one disadvantage** for each of these methods.

Reused

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Recycled

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Burned

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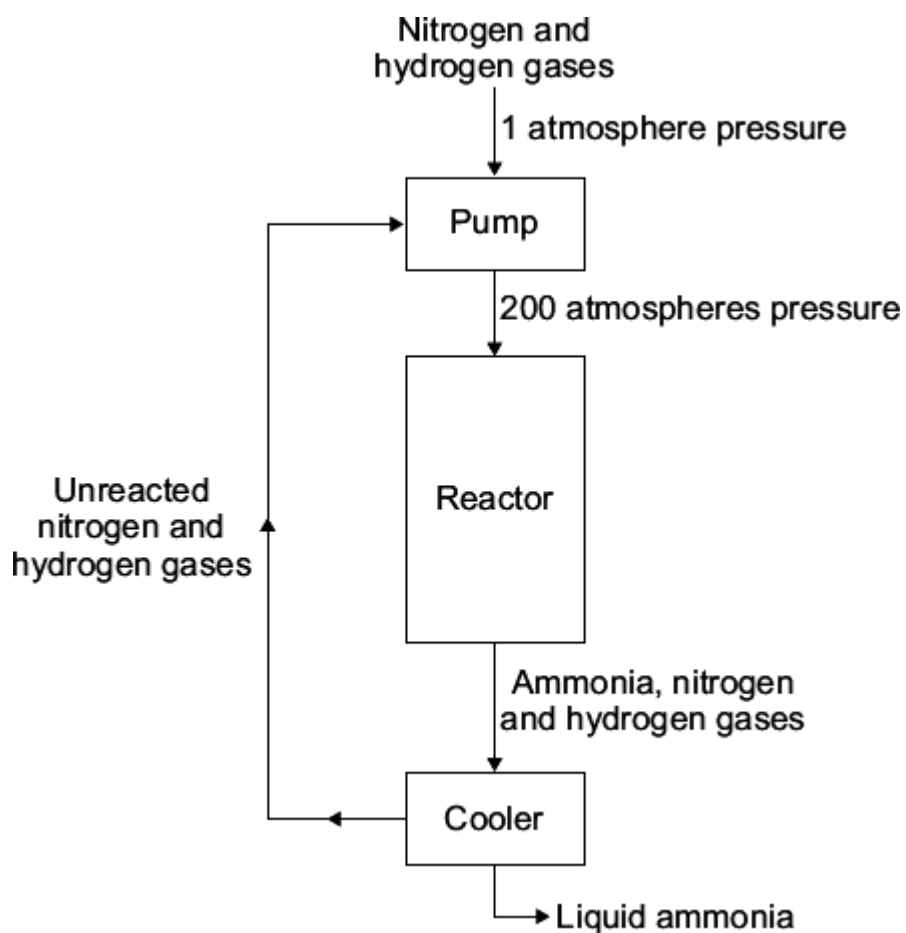
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Dumped

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.....

(4)
(Total 4 marks)



- (a) What effect, if any, does the **pump** have on the pressure of the nitrogen and hydrogen?

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

The pump

decreases
has no effect on
increases

 the pressure.

(1)

- (b) The word equation for making ammonia is:



In the **reactor** only a small amount of the nitrogen and hydrogen is changed into ammonia.

Tick (✓) the reason why.

Reason why	Tick (✓)
Ammonia is formed from two elements.	
Nitrogen and hydrogen are gases.	
The reaction is reversible.	

(1)

- (c) In the **cooler** the mixture of gases is cooled.

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

The cooler turns the ammonia into

a liquid.

a solid.

an element.

(1)

- (d) What happens to the unreacted nitrogen and hydrogen from the **reactor**?

.....

(1)

(Total 4 marks)

56

Good quality water is essential for life.

- (a) In the United Kingdom, water is filtered and treated with chlorine to make it safe to drink.



Explain why the water is:

filtered

.....

treated with chlorine.

.....

(2)

- (b) Millions of people in Bangladesh drink water from wells that contain high levels of arsenic. Arsenic is poisonous.

The World Health Organisation recommends that there should be no more than 0.01 mg of arsenic per litre in drinking water.

The table gives some information about two instrumental methods of testing for arsenic.

Factor to consider	Laboratory Instrumental Method	Portable Instrumental Method
Cost of equipment	£10 000	£50
Skill level of technician	Highly skilled	where test is done
Little training needed	Laboratory only	Anywhere
Time to prepare the instrument for the test	5 minutes	10 seconds
Sensitivity of the instrument	0.000001 mg of arsenic per litre of water	0.1 mg of arsenic per litre of water

- (i) Use the information in the table to give **two** advantages and **one** disadvantage of using the Portable Instrumental Method compared with the Laboratory Instrumental Method.

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(3)

- (ii) The information about these two instrumental methods was provided by the Professional Institute of Water Engineers (PIWE). The Institute has no connection with the companies that make these instruments.

Suggest why many people would accept the views of PIWE rather than the views of the companies that make the instruments.

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(1)
(Total 6 marks)