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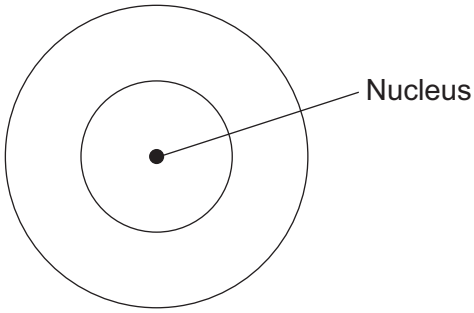
Answer **all** questions in the spaces provided.

1 The picture shows a diamond ring.

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

Draw the electronic structure of a carbon atom.



(1 mark)

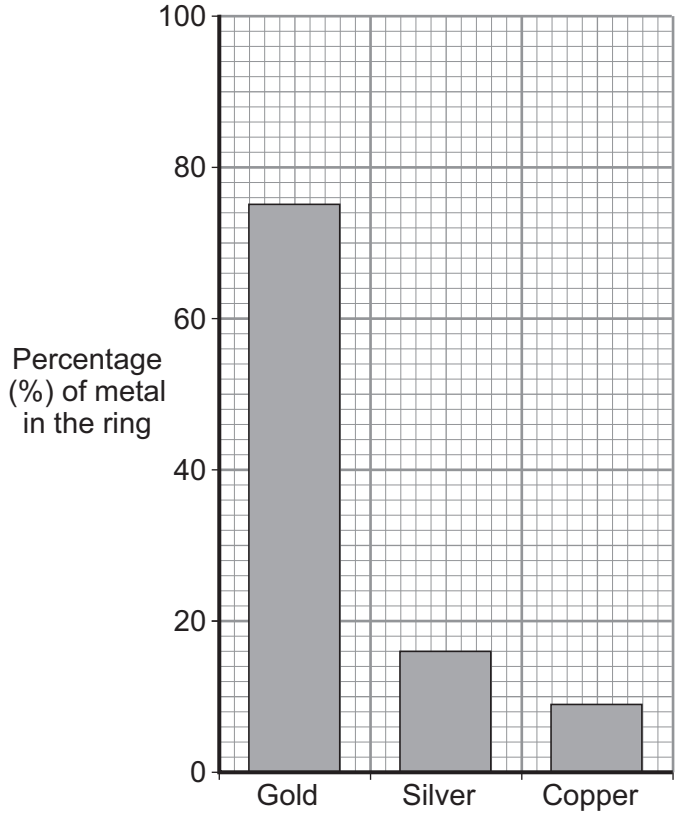
1 (b) A gold atom has an atomic number of 79 and a mass number of 197.

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

Name	Number
Proton	79
Electron	.....
.....	.....

(3 marks)

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



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

Silver is ..... % and copper is ..... %

(1 mark)

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

Give **two** reasons why.

1 .....

.....

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2 .....

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.....

(2 marks)

7

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

2 A mixture of petrol and air is burned in a car engine.
Petrol is a mixture of alkanes. Air is a mixture of gases.

The tables give information about the composition of petrol and the composition of air.

Petrol	
Alkane	**Formula**
hexane	C_6H_{14}
heptane	
octane	C_8H_{18}
nonane	C_9H_{20}
decane	$C_{10}H_{22}$

Air	
Gas	**Percentage (%)**
nitrogen	78
oxygen	21
carbon dioxide	0.035
Small amounts of other gases and water vapour	

2 (a) Use the information above to answer these questions.

2 (a) (i) Give the formula for heptane.

.....

(1 mark)

2 (a) (ii) Complete the general formula of alkanes.
n = number of carbon atoms

$$\mathbf{C_nH}$$

(1 mark)

2 (b) Alkanes in petrol burn in air.
The equations represent two reactions of hexane burning in air.

Reaction 1 $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$

Reaction 2 $2C_6H_{14} + 13O_2 \rightarrow 12CO + 14H_2O$

Reaction 2 produces a different carbon compound to **Reaction 1**.

2 (b) (i) Name the carbon compound produced in **Reaction 2**.

.....

(1 mark)

2 (b) (ii) Give a reason why the carbon compounds produced are different.

.....

.....

(1 mark)

Question 2 continues on the next page

2 (c) The table shows the percentages of some gases in the exhaust from a petrol engine.

Name of gas	Percentage (%)
nitrogen	68
carbon dioxide	15
carbon monoxide	1.0
oxygen	0.75
nitrogen oxides	0.24
hydrocarbons	0.005
sulfur dioxide	0.005
other gases	

2 (c) (i) What is the percentage of the other gases in the table?

.....

(1 mark)

2 (c) (ii) What is the name of the compound that makes up most of the other gases?

.....

(1 mark)

2 (c) (iii) Give a reason why sulfur dioxide is produced in a petrol engine.

.....

.....

(1 mark)

2 (c) (iv) State how nitrogen oxides are produced in a petrol engine.

.....

.....

.....

.....

(2 marks)

2 (d) Many scientists are concerned about the carbon dioxide released from burning fossil fuels such as petrol.

Explain why.

.....

.....

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(2 marks)

11

Turn over for the next question

Do not write outside the box

3 There are about 500 000 earthquakes every year. On 12 January 2010 there was an earthquake near Port-au-Prince in Haiti. Many buildings were destroyed causing the deaths of thousands of people. The earthquake did not come as a surprise to scientists who predicted the earthquake a week earlier. The Government and people ignored the prediction.

The Richter scale is used to compare the size of earthquakes.

Richter scale value	Effect of earthquake
Less than 2	People do not feel the earthquake.
2 – 4	People feel the earthquake but the earthquake rarely causes damage to buildings.
4 – 5	People feel the earthquake and the earthquake causes minor damage to a few buildings.
5 – 6	Shaking of the ground and major damage to some buildings.
6 – 8	Violent shaking of the ground and many buildings destroyed.
8 – 10	Very violent shaking of the ground and most buildings destroyed.

3 (a) Use the information above to answer these questions.

3 (a) (i) Suggest the Richter scale value for the earthquake that happened near Port-au-Prince in Haiti.

.....

(1 mark)

3 (a) (ii) Governments and people often ignore scientists' predictions of an earthquake.

Suggest **three** reasons why.

1 .....

.....

.....

2 .....

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3 .....

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.....

(3 marks)

3 (b) During the twentieth century many scientists proposed ideas about the cause of earthquakes and about the Earth's crust.
In 1912 Alfred Wegener proposed his idea of '*continental drift*'.
In 1930 Arthur Holmes suggested his idea of '*mantle dynamics*'.

3 (b) (i) What did Wegener mean by *'continental drift'*?

.....

.....

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.....

.....

(2 marks)

3 (b) (ii) Holmes' idea of '*mantle dynamics*' provided an explanation for Wegener's idea of *'continental drift'.*

Suggest what *'mantle dynamics'* is and state what causes *'mantle dynamics'*.

.....

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(2 marks)

8

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

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

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

.....

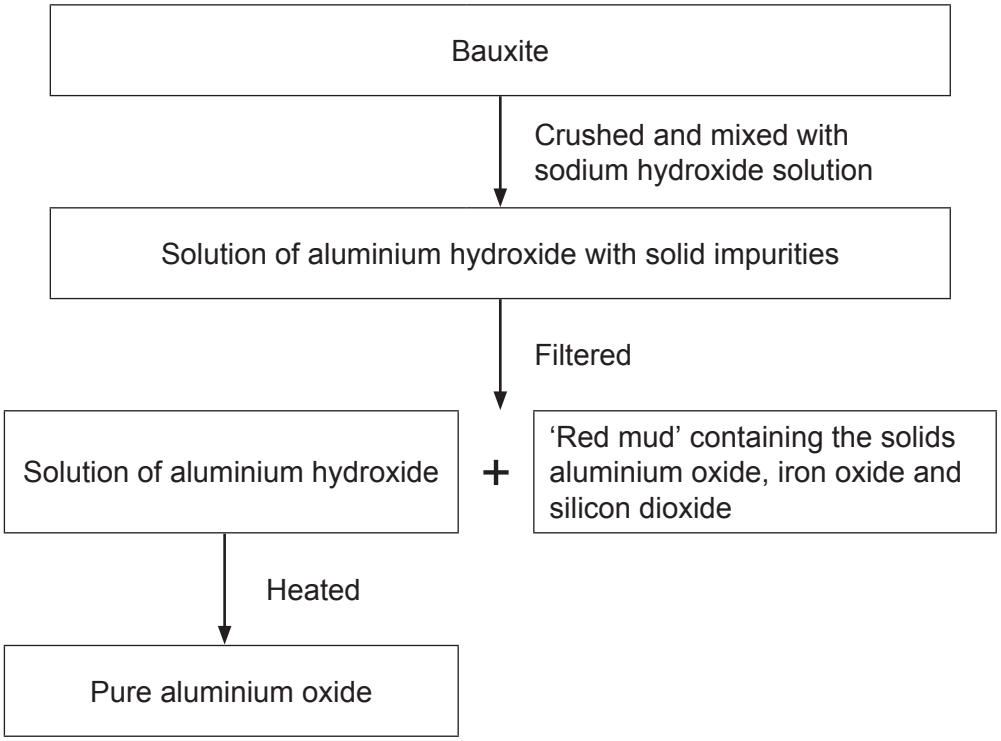
(1 mark)

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

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

(1 mark)

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



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

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

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

What percentage of aluminium oxide did the bauxite contain?

.....

Answer = ... %

(1 mark)

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

.....

(1 mark)

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

Suggest **one** reason why.

.....

(1 mark)

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

During one year in the USA:

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

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

Environmental .....

.....

Ethical or social .....

.....

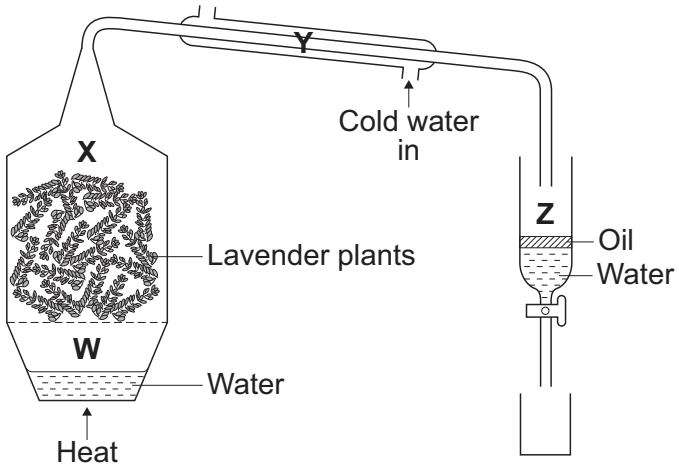
(2 marks)

7

5 This question is about plant oils.

5 (a) Steam distillation is used to separate oils from plants.

The diagram shows some apparatus that can be used to separate oil from lavender plants.
Four parts of the apparatus are labelled **W**, **X**, **Y** and **Z**.



Describe how lavender oil is separated from the plant material.

You need to describe what happens in each of the parts, **W**, **X**, **Y** and **Z**, of the apparatus.

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(4 marks)

5 (b) Olive oil can be used in the manufacture of margarine.
Olive oil has a melting point of –6 °C and contains about 11 % saturated fat and 89 % unsaturated fat.

5 (b) (i) Describe a test to show that olive oil contains unsaturated compounds.

Give the result of the test.

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(2 marks)

5 (b) (ii) To make margarine from olive oil the percentage of unsaturated fat needs to be decreased.

Give **one** reason why.

.....

.....

(1 mark)

5 (b) (iii) Describe how to decrease the percentage of unsaturated fat in olive oil.

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(3 marks)

10

6 Limestone is used as a building material. Acid rain erodes limestone.

6 (a) Limestone contains calcium carbonate.
The symbol equation for the reaction of calcium carbonate with hydrochloric acid is shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Describe a test to show that carbon dioxide is produced in this reaction.

Give the result of the test.

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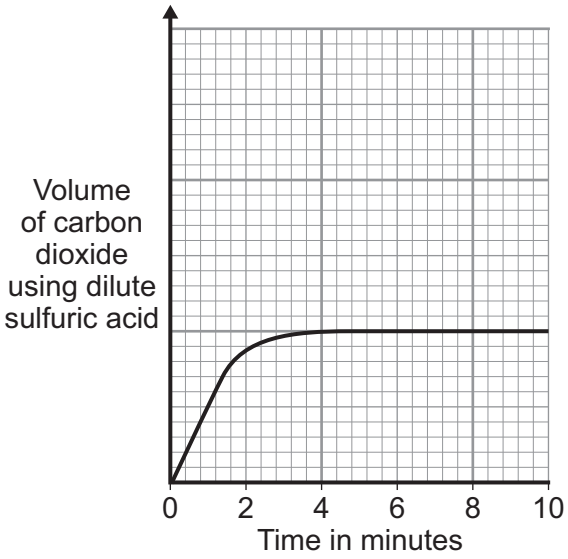
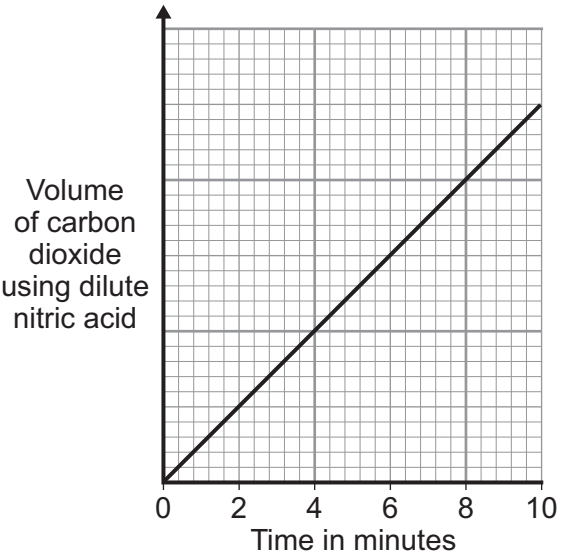
(2 marks)

6 (b) Gases from vehicle exhausts produce sulfuric acid and nitric acid.

A student investigated the reaction of these two acids with calcium carbonate (limestone).
The type of acid was changed but all other variables were kept the same.
The student measured the volume of carbon dioxide produced each minute for a total of 10 minutes. He did this first for the reaction between dilute sulfuric acid and a cube of calcium carbonate (limestone).
The student repeated the experiment using dilute nitric acid in place of the dilute sulfuric acid.
The results are shown below.





6 (b) (i) State **two** variables that must be kept the same for this investigation.

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.....

(2 marks)

6 (b) (ii) Reacting calcium carbonate with sulfuric acid gave different results to nitric acid.

The symbol equations for the reaction of calcium carbonate with sulfuric acid and with nitric acid are shown below.

$CaCO_3(s) + H_2SO_4(aq) \rightarrow CaSO_4(s) + H_2O(l) + CO_2(g)$

$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$

Describe how the results for sulfuric acid are different **and** use the symbol equations to explain this difference.

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(3 marks)

7

Turn over for the next question

7 Ethene is used as a starting material for the production of many other substances, including ethanol.

7 (a) Ethene is produced when hydrocarbons are cracked. To do this hydrocarbons are heated to vaporise them. The vapours are then passed over a hot catalyst. The symbol equation shows the reaction for one hydrocarbon.

$$C_{28}H_{58} \rightarrow C_{11}H_{24} + C_{11}H_{22} + C_4H_8 + C_2H_4$$

7 (a) (i) One of the products is a different type of hydrocarbon to the other products.

Complete the sentences.

The formula of the product that is a different type of hydrocarbon is ..... .

The chemical structure of this product is different to the other products because

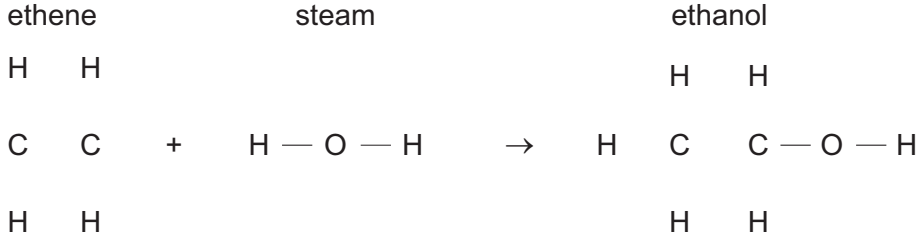
.....

.....

(2 marks)

7 (a) (ii) Ethanol is produced when ethene reacts with steam in the presence of a hot catalyst.

Draw the missing bonds to complete the displayed structures in the equation.



(2 marks)

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

In 1970, the Brazilian Government had stated that all petrol must contain more than 25 % ethanol. The reasons for this statement in 1970 were:

- the oilfields in Brazil at that time only supplied 20 % of the crude oil needed to make petrol
- Brazil has a climate suitable for growing sugar cane.

To produce ethanol the sugar cane plants are crushed and soaked in water for one day. The sugar solution is separated from the plant material by filtration. Yeast is added to the sugar solution and fermented for three days. The yeast is separated from the solution of water and ethanol by filtration. Ethanol is separated from water by fractional distillation.

In 2011, the Brazilian Government decided to reduce the amount of ethanol in petrol to 18%. The reasons were that in 2011:

- the demand for ethanol and the price of ethanol had greatly increased
- very large offshore oilfields had been discovered. These offshore oilfields would make Brazil one of the biggest crude oil producers in the world.

Use the information above and your own knowledge and understanding to evaluate whether Brazil should in future produce ethanol from crude oil or produce ethanol from sugar cane.

You should include environmental and economic or social factors in your evaluation.

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(6 marks)

10

END OF QUESTIONS

Answer ALL questions

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The reactivity series

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

most reactive	calcium
	magnesium
	aluminium
	zinc
	iron
	copper
least reactive	gold

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

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

(1)

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

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

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

(1)

.....

.....

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

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

(2)

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

Explain why the aluminium alloy is stronger than pure aluminium.

(2)

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.....

.....

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

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

(2)

..... Al + ... O_2 → $2Al_2O_3$

(Total for Question 1 = 8 marks)

Carbon dioxide levels in the atmosphere

2 Scientists believe that, about 4500 million years ago, the Earth was very much hotter than it is now.
The atmosphere then was very different from that on Earth today.

(a) Explain why it is difficult to be precise about the composition of the Earth's early atmosphere.

(2)

(b) As the Earth cooled, oceans formed.

How did this affect the composition of the atmosphere?

(1)

(c) The first plants appeared about 400 million years ago.

Explain how the growth of these plants affected the composition of the atmosphere.

(2)

(d) What is the current approximate percentage of carbon dioxide in the Earth's atmosphere?

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

(1)

- ☒ **A** 0.04
- ☒ **B** 1.0
- ☒ **C** 4.0
- ☒ **D** 10

(e) The amount of carbon dioxide in the Earth's atmosphere has been rising over the past fifty years, mainly caused by an increase in the quantity of fossil fuels that have been burned.

State another cause of increasing amounts of carbon dioxide in the atmosphere.

(1)

.....

.....

(Total for Question 2 = 7 marks)

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Hydrocarbons

3 (a) During fractional distillation, crude oil is separated into a number of fractions.

The table shows the relative amount of these fractions that can be obtained from crude oil.

The table also shows the relative demand for each of these fractions.

fraction	relative amount obtained	relative demand
LPG	2	6
petrol	12	29
kerosene	16	11
diesel	24	29
fuel oil and bitumen	46	25

(i) For which fractions does the demand exceed the supply?

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

(1)

☒ **A** kerosene, diesel, fuel oil and bitumen

☒ **B** LPG, petrol and diesel

☒ **C** LPG, petrol and kerosene

☒ **D** petrol, diesel, fuel oil and bitumen

(ii) In another process, called cracking, large molecules in some fractions are converted into smaller molecules.

Explain why cracking is needed.

(2)

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.....

.....

(b) The table shows the number of carbon atoms per molecule in the substances present in each of the fractions.

fraction	number of carbon atoms per molecule
LPG	1 – 4
petrol	4 – 12
kerosene	9 – 16
diesel	15 – 25
fuel oil and bitumen	over 25

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

(1)

As the number of carbon atoms in the molecules of a hydrocarbon increases

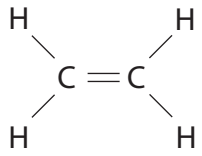
☒ **A** the number of hydrogen atoms in the molecule remains the same

☒ **B** the boiling point of the hydrocarbon increases

☒ **C** the hydrocarbon becomes easier to burn

☒ **D** the viscosity of the hydrocarbon decreases

(c) The structure of a molecule of ethene is



(i) What is the formula of a molecule of ethene?

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

(1)

☒ **A** CH_2

☒ **B** C_2H_4

☒ **C** C_nH_{2n}

☒ **D** $(CH_2)_n$

(ii) Ethene can be converted into poly(ethene).

Write a balanced equation for this reaction.

(2)

(d) Many power stations generate electricity by burning fossil fuels, such as fuel oil. This process adds carbon dioxide to the atmosphere.

(i) Explain why some people are concerned about the increase in the amount of carbon dioxide in the atmosphere.

(2)

(ii) Some hydrocarbon fuels can contain sulfur impurities.

Explain how the product of combustion of these sulfur impurities affects the environment.

(2)

(Total for Question 3 = 11 marks)

Calcium compounds

4 Calcium carbonate is an important raw material in the chemical industry.
It exists naturally as chalk, marble and limestone.

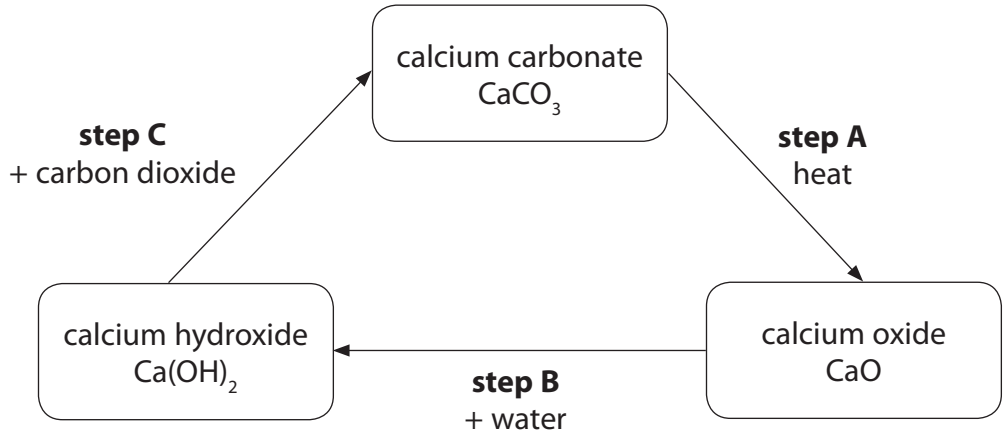
(a) Which row of the table correctly identifies chalk, marble and limestone as sedimentary or metamorphic rocks?

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

(1)

		chalk	marble	limestone
☒	**A**	sedimentary	sedimentary	metamorphic
☒	**B**	metamorphic	metamorphic	sedimentary
☒	**C**	sedimentary	metamorphic	sedimentary
☒	**D**	metamorphic	sedimentary	metamorphic

(b) The diagram shows reactions of some calcium compounds.



(i) Both calcium carbonate and calcium oxide are white solids.

Suggest how you could show that, when calcium carbonate is heated, a reaction takes place.

(2)

.....

.....

.....

.....

(ii) Describe what you would observe when water is added, one drop at a time, to cold calcium oxide (**step B**).

(2)

(iii) Write the balanced equation for the reaction of calcium hydroxide with carbon dioxide (**step C**).

(2)

(iv) State the common name for calcium hydroxide solution.

(1)

(c) Explain why calcium carbonate removes acidic gases from emissions in power station chimneys.

(2)

(Total for Question 4 = 10 marks)

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Electrolysis

5 Electrolysis occurs when solutions of some compounds are decomposed by passing direct electric current through them.

(a) Sodium chloride solution was electrolysed.
The reaction produced chlorine and hydrogen.
The remaining solution contained sodium hydroxide, NaOH.

(i) State a hazard associated with chlorine gas.

(1)

.....

(ii) Describe a test that can be used to identify a sample of gas as chlorine.

(2)

.....

.....

.....

.....

(iii) State a use of chlorine.

(1)

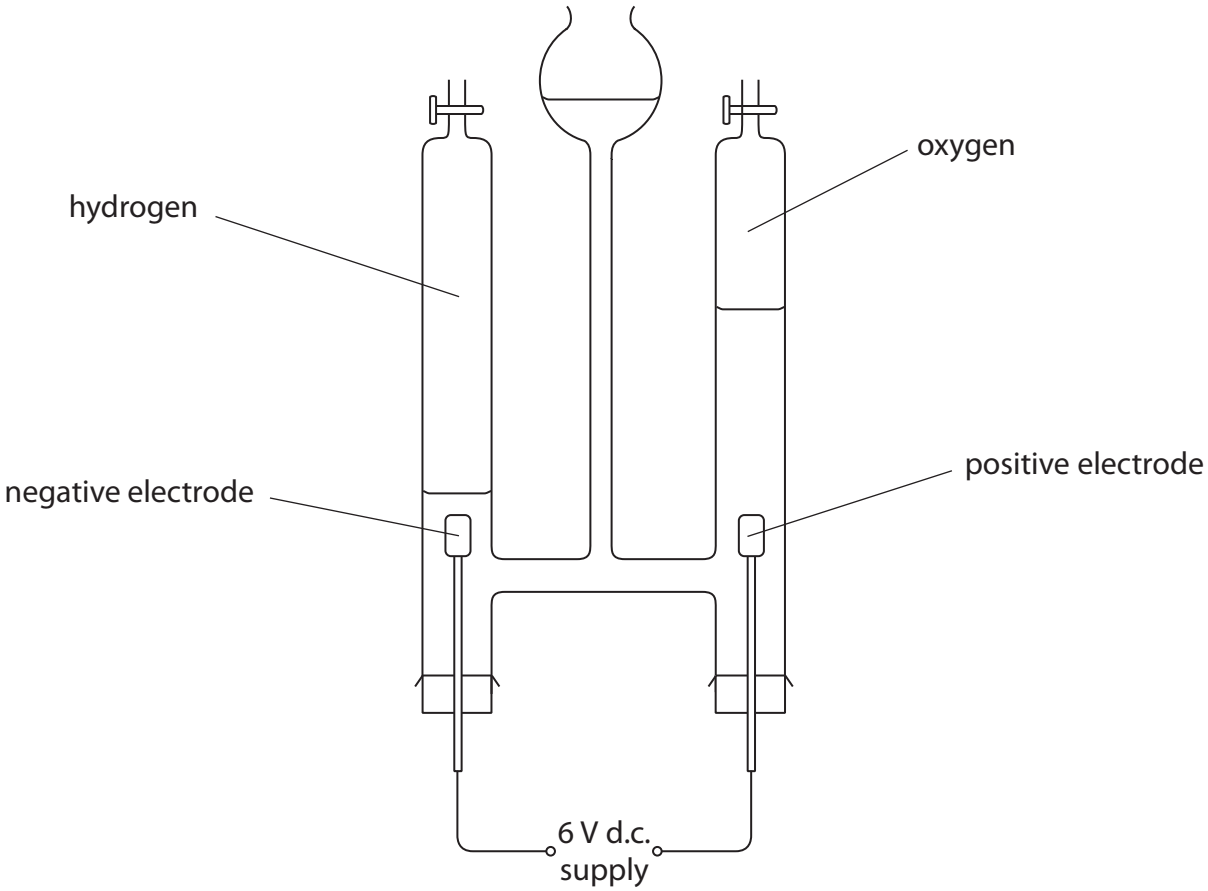
.....

(iv) Complete and balance the equation for the overall reaction taking place when sodium chloride solution is electrolysed.

(2)

..... NaCl + ... H_2O → ..... + ... + ...

*(b) Water was decomposed by electrolysis in the apparatus shown.



The water decomposed into hydrogen and oxygen.
After five minutes, the volumes of hydrogen and oxygen in the tubes were measured.

Two further experiments were carried out changing only one factor in each experiment. All other factors were kept the same.

The table shows the conditions and results of all three experiments.

experiment	time / minutes	current / amps	volume of hydrogen / cm^3	volume of oxygen / cm^3
1	5	0.50	20.0	10.0
2	10	0.50	40.0	20.0
3	5	0.75	30.0	15.0

Use these results of electrolysis to compare the volumes of hydrogen and oxygen formed and to show the effect of changing the time and the current on the volumes of these gases.

(6)

(Total for Question 5 = 12 marks)

Alternative fuels

6 Known crude oil deposits are being used up.
In the past, most of our fuels, such as petrol, have been obtained from crude oil.

(a) Fuels such as those obtained from crude oil are non-renewable. Efforts are being made to replace these types of fuels with renewable fuels.

Explain the difference between **non-renewable** and **renewable** fuels.

(2)

*(b) Evaluate the advantages and disadvantages of using bioethanol, instead of petrol, as a fuel for cars.

(6)

(c) The photograph shows one of the new buses for London.

The bus uses hydrogen as a fuel.
There are six hydrogen fuel tanks, which can be seen on the roof of the bus.
The hydrogen from the tanks reacts with oxygen from the air in a fuel cell to release energy to power the bus.

(i) Write the balanced equation for the overall reaction that takes place when the hydrogen reacts with oxygen in the fuel cell.

(3)

.....

(ii) Like all fuels, hydrogen, when mixed with air and ignited, explodes.

Apart from the possibility of an explosion, state another disadvantage of using hydrogen, rather than diesel, as a fuel for buses.

(1)

.....

.....

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

Answer ALL questions

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Group 3

1 The elements in group 3 of the periodic table are boron, aluminium, gallium, indium and thallium.

(a) Elements can be classified as metals or non-metals.

Explain, using its position in the periodic table, whether indium is a metal or a non-metal.

(2)

.....

.....

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.....

(b) Each aluminium atom has 13 electrons.

State the electronic configuration of an aluminium atom.

(1)

.....

(c) Boron has an atomic number of 5.
There are two isotopes of boron, boron-10 and boron-11.

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

Every boron atom contains

(1)

☒ **A** five protons

☒ **B** five neutrons

☒ **C** eleven electrons

☒ **D** eleven neutrons

(ii) Explain what is meant by the term **isotopes**.

(2)

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(iii) A sample of boron contains the two isotopes, boron-10 and boron-11.
The relative atomic mass of boron is 10.8

Give the reason why the relative atomic mass is closer to 11 than 10.

(1)

.....

.....

(Total for Question 1 = 7 marks)

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Patterns in properties

2 (a) Copper is a metal.

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

Copper conducts electricity because particles in it move through the structure. These particles are

(1)

☒ **A** positive and negative ions

☒ **B** positive ions only

☒ **C** atoms

☒ **D** electrons

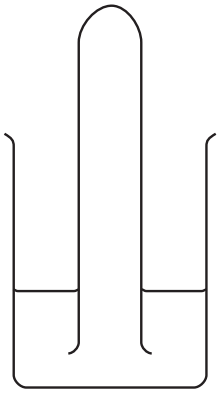
(ii) Copper forms coloured compounds.

Give the name of the type of metals that form coloured compounds.

(1)

.....

(b) A test tube was filled with hydrogen chloride gas.
The test tube was inverted in water and left.



The liquid level rose up to the top of the test tube.

Explain what was formed in the test tube after the water had entered.

(2)

(c) When chlorine is bubbled into potassium bromide solution, the solution turns orange.

Explain why this happens.

(2)

(d) Barium sulfate can be prepared as a white precipitate.

Describe how you could prepare a pure, dry sample of barium sulfate from barium chloride solution and sodium sulfate solution.

(3)

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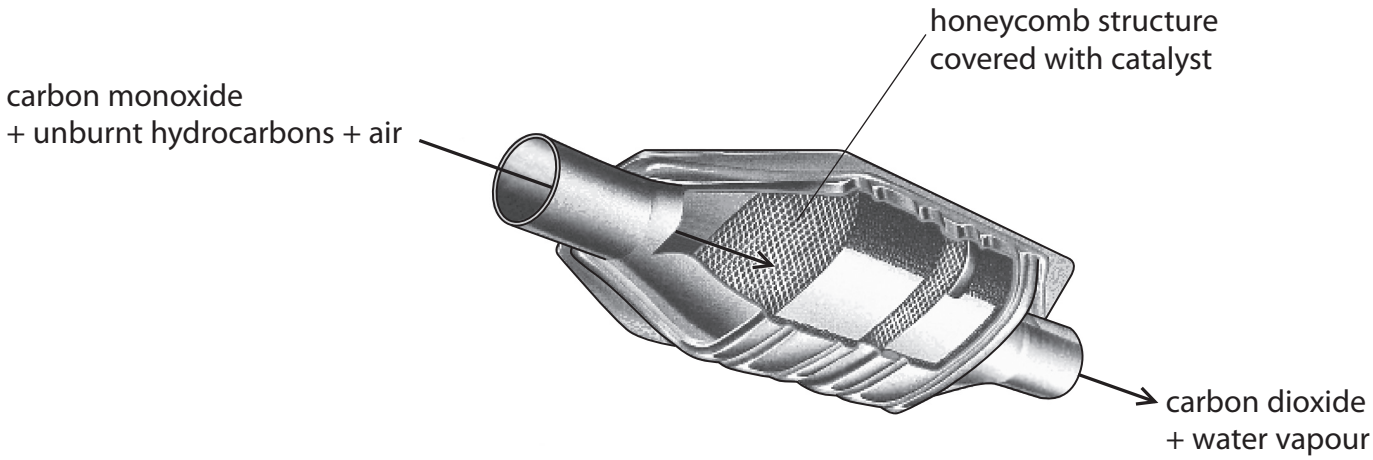
(Total for Question 2 = 9 marks)

Rates of reaction

3 The diagram shows a catalytic converter used in car exhaust systems.
Gases from the car engine pass into the catalytic converter.
In the catalytic converter, carbon monoxide and unburnt hydrocarbons are changed into carbon dioxide and water vapour.



(a) What type of reaction occurs in the catalytic converter?

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

(1)

☒ **A** cracking

☒ **B** displacement

☒ **C** oxidation

☒ **D** precipitation

(b) It is important that the reactions in the catalytic converter happen quickly.

(i) Explain why the catalyst is spread onto the honeycomb structure rather than used as large pieces.

(2)

.....

.....

.....

.....

(ii) Hot gases from the engine pass over the catalyst.

Explain why the catalyst is more effective when the engine has been running for a short time rather than when the engine is first started.

(2)

.....

.....

.....

.....

(c) Carbon monoxide reacts with oxygen, O_2, to form carbon dioxide in the catalytic converter.

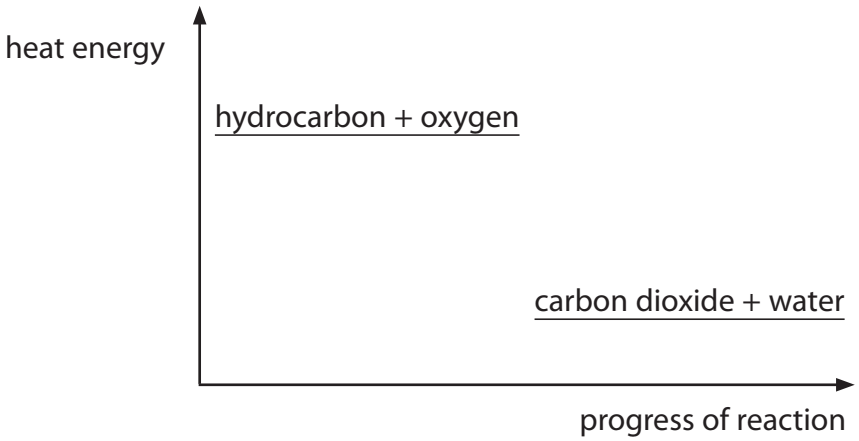
Write the balanced equation for this reaction.

(3)

.....

(d) In the catalytic converter, a hydrocarbon is converted to carbon dioxide and water.

The diagram shows the heat energies of the reactants and products in this reaction.



Explain what the diagram shows about the type of reaction occurring.

(2)

.....

.....

.....

.....

(Total for Question 3 = 10 marks)

Metal halides

4 (a) Copper(II) chloride contains copper ions, Cu^{2+}, and chloride ions, Cl^-.

(i) What is the formula of this copper chloride?

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

(1)

☒ **A** CuCl

☒ **B** Cu_2Cl

☒ **C** $CuCl_2$

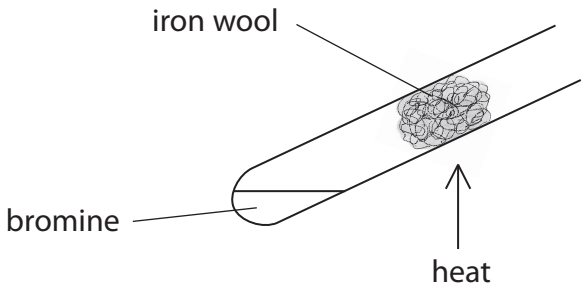
☒ **D** Cu_2Cl_2

(ii) In a reaction 0.64 g copper are reacted to produce copper chloride. The theoretical yield of this reaction is 1.35 g copper chloride.

Explain what is meant by **theoretical yield**.

(2)

(b) Bromine reacts with hot iron wool to produce solid iron(III) bromide, $FeBr_3$.



(i) Write the balanced equation for the reaction between iron and bromine gas.
Include state symbols.

(3)

.....

(ii) Calculate the relative formula mass of iron(III) bromide, $FeBr_3$.
(Relative atomic masses: Fe = 56, Br = 80)

(1)

.....

.....

relative formula mass = ...

(iii) Iron also reacts with iodine to form iron(II) iodide, FeI_2.

Calculate the percentage by mass of iron in iron(II) iodide.
(Relative formula mass FeI_2 = 310)

(2)

.....

.....

.....

percentage by mass of iron = ...%

(iv) Hydrogen peroxide reacts with some iron compounds.
The molecular formula of hydrogen peroxide is H_2O_2.

Give the empirical formula of hydrogen peroxide.

(1)

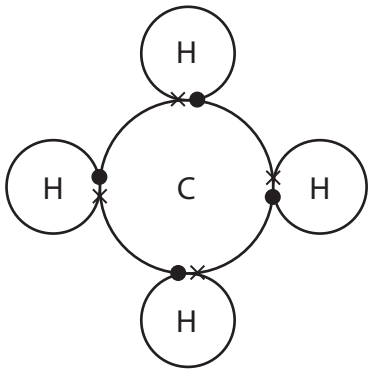
.....

(Total for Question 4 = 10 marks)

Covalent substances

5 Many substances exist as molecules.

(a) The diagram shows the outer shell electrons in a molecule of methane, CH_4.



(i) Each hydrogen atom is bonded to the carbon atom by a covalent bond.

Give the meaning of the term **covalent bond**.

(1)

.....

.....

.....

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

Methane is a typical simple molecular, covalent compound.

A property of methane is that

(1)

☒ **A** it has a high melting point

☒ **B** it is a good conductor of electricity

☒ **C** there are weak bonds in its molecule

☒ **D** it has a low boiling point

(b) Nitrogen and oxygen are gases in air.

Describe how samples of nitrogen and oxygen can be obtained from air.

(3)

*(c) Graphite is a form of the element carbon.
Graphite is a giant molecular, covalent substance.

Use the structure and bonding in graphite to explain why it is able to be used as a lubricant and as a conductor of electricity.

(6)

(d) Give a use of graphite that depends on its ability to conduct electricity.

(1)

(Total for Question 5 = 12 marks)

Sodium chloride

6 (a) The table shows some information about the atoms and the ions of chlorine and sodium.

Complete the table.

(3)

	symbol of		number of electrons in	
	atom	**ion**	**atom**	**ion**
chlorine	Cl	Cl^-	17	
sodium	Na			10

(b) When silver nitrate solution, $AgNO_3$, is added to sodium chloride solution a white precipitate is formed.

(i) Write the balanced equation for this reaction.

(2)

.....

(ii) Silver nitrate solution can be added to a solution to test for the presence of chloride ions.
In this test, dilute nitric acid is added to the solution, followed by the silver nitrate solution.
A white precipitate shows the presence of chloride ions.

Why must the dilute nitric acid be added to make this a reliable test?

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

(1)

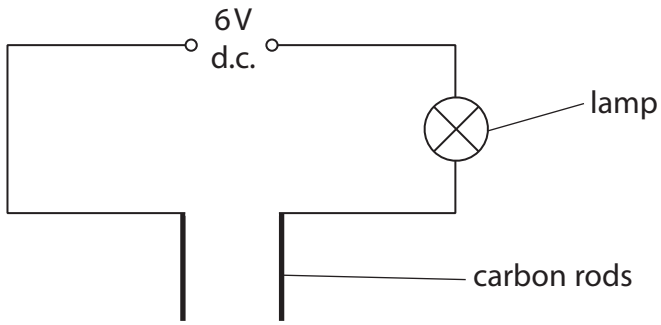
☒ **A** to dilute the solution of chloride ions

☒ **B** because the precipitate only forms if dilute nitric acid is added

☒ **C** to stop the white precipitate changing colour

☒ **D** to remove other ions that would also form a white precipitate

*(c) This circuit was used to test the ability of water, solid sodium chloride and sodium chloride solution to conduct electricity.



The results were

substance	conducts electricity
water	no
solid sodium chloride	no
sodium chloride solution	yes

Explain these results by referring to the structures of the substances.

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

Answer **all** the questions.

1 Cars on motorways use the right hand lane for overtaking. The left hand lanes are used for slower vehicles.

From 2007, car pool lanes will be introduced on some motorways.
Only cars with two or more people in them will be allowed to drive in the right hand lane.

(a) The effect of car pool lanes is beneficial to those who use them and to the environment.

Here are **six** statements about the effects of car pool lanes.

A	Less fossil fuel will be extracted.
B	There will be traffic jams in the left hand lanes.
C	Journeys to work will be cheaper.
D	It will be dangerous to drive in the right hand lane.
E	There will be less air pollution.
F	Journeys to work will be faster.

(i) Which **two** statements from **A**, **B**, **C**, **D**, **E** or **F** benefit **only** those who use car pool lanes?

answer …… and …… [1]

(ii) Which **two** statements from **A**, **B**, **C**, **D**, **E** or **F** benefit the environment?

answer …… and …… [1]

(b) Pollution from car engines includes nitrogen oxides.

(i) How are nitrogen oxides produced in a car engine?

Put a tick (✓) in the box next to the **best** answer.

By the reaction of petrol with oxygen in the air. ☐

By reactions in catalytic converters. ☐

By the reaction of petrol with nitrogen in the air. ☐

By the reaction of nitrogen and oxygen from the air. ☐ [1]

(ii) Why are nitrogen oxides harmful?

Put ticks (✓) in the boxes next to the correct answers.

They react with carbon monoxide to make nitrogen. ☐

They cause breathing difficulties. ☐

They react with water and oxygen to make acid rain. ☐

They stop photosynthesis in plants. ☐ [1]

(c) Which of the following will reduce nitrogen oxide pollution from cars?

Put ticks (✓) in the boxes next to the correct answers.

Using low sulfur fuel. ☐

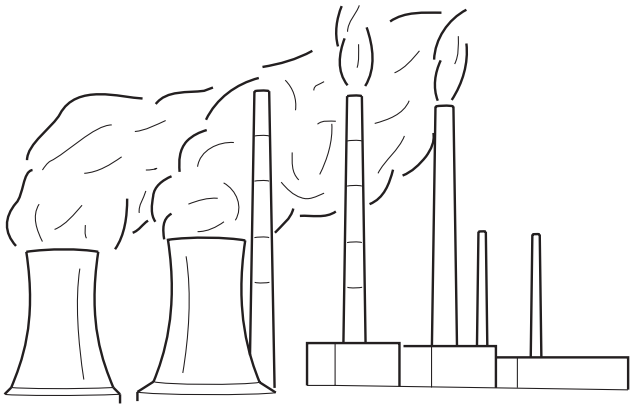
Building cars that last longer. ☐

Adding catalytic converters to car exhaust systems. ☐

Making car engines that work at lower temperatures. ☐ [2]

[Total: 6]

2 This question is about pollution from power stations.



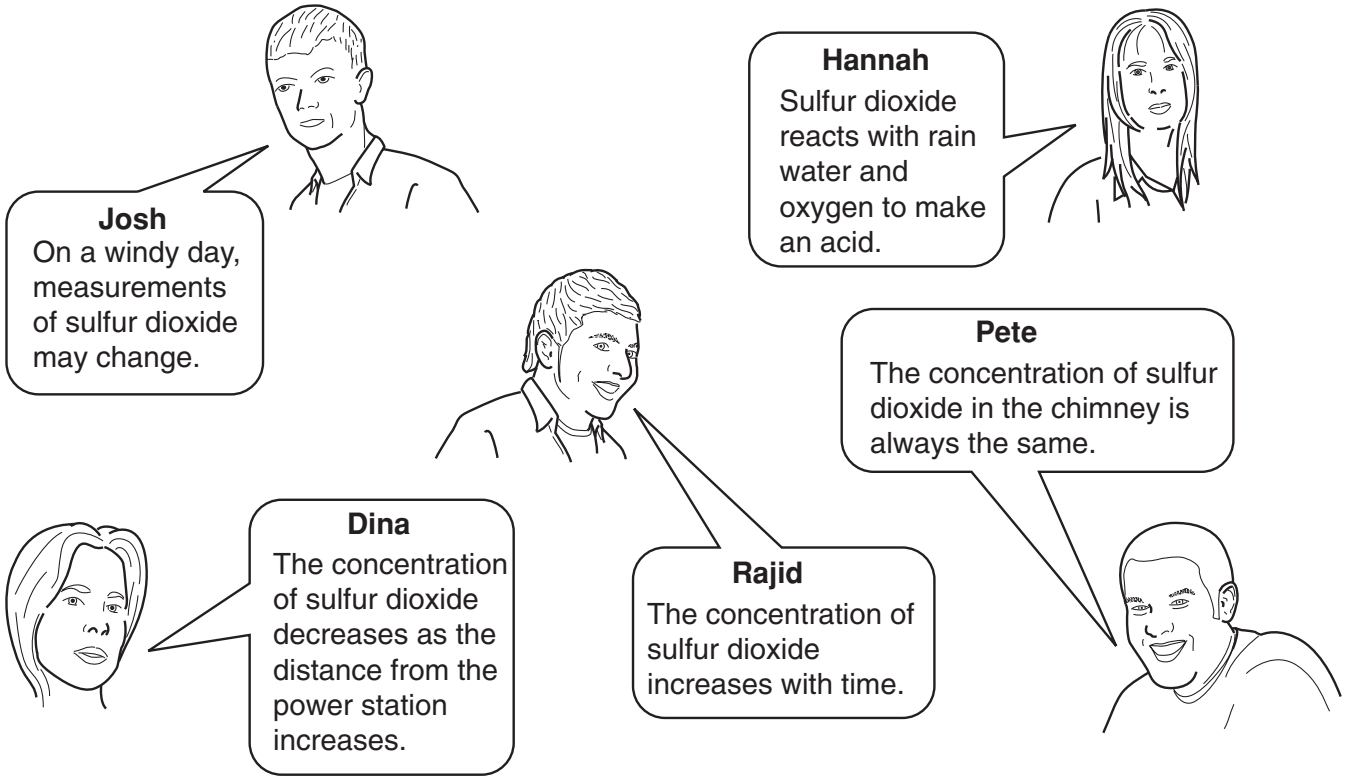
One of the pollutants from power stations is sulfur dioxide.

Sulfur dioxide levels are measured at different distances from a power station. The table shows the results on one day.

distance from power station m	**concentration of sulfur dioxide µg / m^3**
0	64
500	50
1000	14
1500	8
2000	3

Levels of sulfur dioxide higher than 50 µg/m^3 are considered harmful to humans.

Here is what five students said about the data in the table.



(a) Which **one** person has described the correlation in the table?

..... [1]

(b) On another day, the concentrations of sulfur dioxide are lower.

Which **two** people have suggested explanations for this change?

..... [2]

(c) Who has explained how sulfur dioxide is removed from the air?

..... [1]

[Total: 4]

3 This question is about chemical reactions.

Petrol is a liquid fuel. In a car engine, it burns in oxygen from the air to transfer energy.

The products of this reaction are carbon dioxide and water vapour.

Carbon dioxide and water vapour are gases.

(a) Which of the following statements show that the properties of **reactants** are different from properties of **products** of this reaction?

Put ticks (✓) in the boxes next to the correct answers.

Petrol is a liquid and oxygen is a gas. ☐

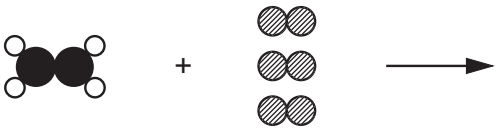
Petrol is a liquid and carbon dioxide and water vapour are gases. ☐

Water vapour condenses in the air. ☐

Petrol burns while carbon dioxide and water vapour do not. ☐

[1]

(b) Complete the diagram below to show the products made when the hydrocarbon ethene is burned in oxygen.



ethene + oxygen ⟶ carbon dioxide + water

key	
●	carbon atom
○	hydrogen atom
◍	oxygen atom

[3]

[Total: 4]

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Question 4 starts on page 8.

PLEASE DO NOT WRITE ON THIS PAGE

4 A supermarket is encouraging customers to re-use plastic carrier bags.

These carrier bags are made of polythene.

(a) Finish each sentence about polythene.

(i) The raw material used to make polythene is …… . [1]

(ii) The process of forming long chains by joining small molecules is called

…… . [1]

(b) The supermarket plans to make their bags **thicker**.

They say this will improve the Life Cycle Assessment (LCA) of the bags.

Which of the following statements when **put together** explain this?

Put ticks (✓) in the correct boxes.

Plastic bags are disposed of in landfill.	☐
Thicker bags are heavier.	☐
Thicker bags last longer.	☐
Transporting thicker bags is more expensive.	☐
The total amount of plastic used is less.	☐
Making thicker bags uses more energy.	☐

[1]

(c) Plastic bags can be disposed of by **landfill** or **incineration**.

Write down the name of another method of disposal.

answer …… [1]

(d) Some scientists believe that incineration is a better way of disposing of plastic bags than landfill.

Which **two** of the following statements when **put together** explain why **incineration** has less environmental impact than **landfill**?

Put ticks (✓) in the boxes next to the **two** correct answers.

They are burned at high temperatures. ☐

The energy made when they burn is wasted. ☐

The need for burning fuel from crude oil is reduced. ☐

Incinerators need energy to be built. ☐

The waste has to be collected. ☐

The energy made when they burn is used. ☐

[1]

(e) It is possible to make **biodegradable** plastic bags.

What is the advantage of biodegradable plastic bags?

Put a tick (✓) in the box next to the **best** answer.

There is no need to take them to landfill. ☐

Carbon dioxide is released as the bags biodegrade. ☐

They take up space in landfill but then rot away. ☐

They don't take up space in landfill. ☐

[1]

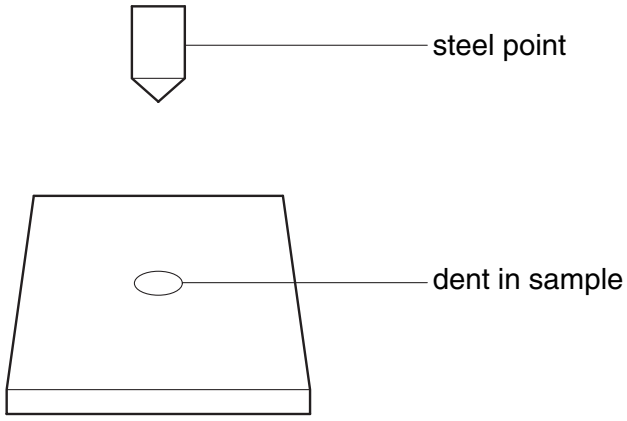
[Total: 6]

5 A scientist measures the hardness of two different materials, **X** and **Y**.

A machine presses a steel point into samples of each material.

The machine uses the same force each time.

A hardness number is calculated from the size of the dent in the sample: the higher the number the harder the material.



(a) Each type of material is tested several times. The results are shown in the table.

	hardness number						
material	**sample 1**	**sample 2**	**sample 3**	**sample 4**	**sample 5**	**sample 6**	**mean**
X	8	10	9	8	7	12	9
Y	18	20	16	7	21	20	19

The mean hardness has been calculated for each material.

One result has not been used to calculate the mean for **material Y** because it is an outlier.

(i) Which result is the outlier?

Put a (ring) around the correct sample number.

1 **2** **3** **4** **5** **6** [1]

(ii) Here are four suggestions why this test gave the wrong result.

A	Samples of X and Y had been mixed up.
B	The steel point had been pressed with a larger force.
C	The steel point had been pressed with a smaller force.
D	The steel point had not been pressed into the sample.

Write down the letters of the **two** best suggestions.

answer …… and …… [2]

(b) All the test results for material X are reliable, but there are small differences between their values.

Why are these values different?

Put a tick (✓) in the box next to the correct answer.

Samples of X and Y had been mixed up. ☐

Samples of X may vary. ☐

It is not a fair test. ☐

The steel point had not been pressed into the samples. ☐ [1]

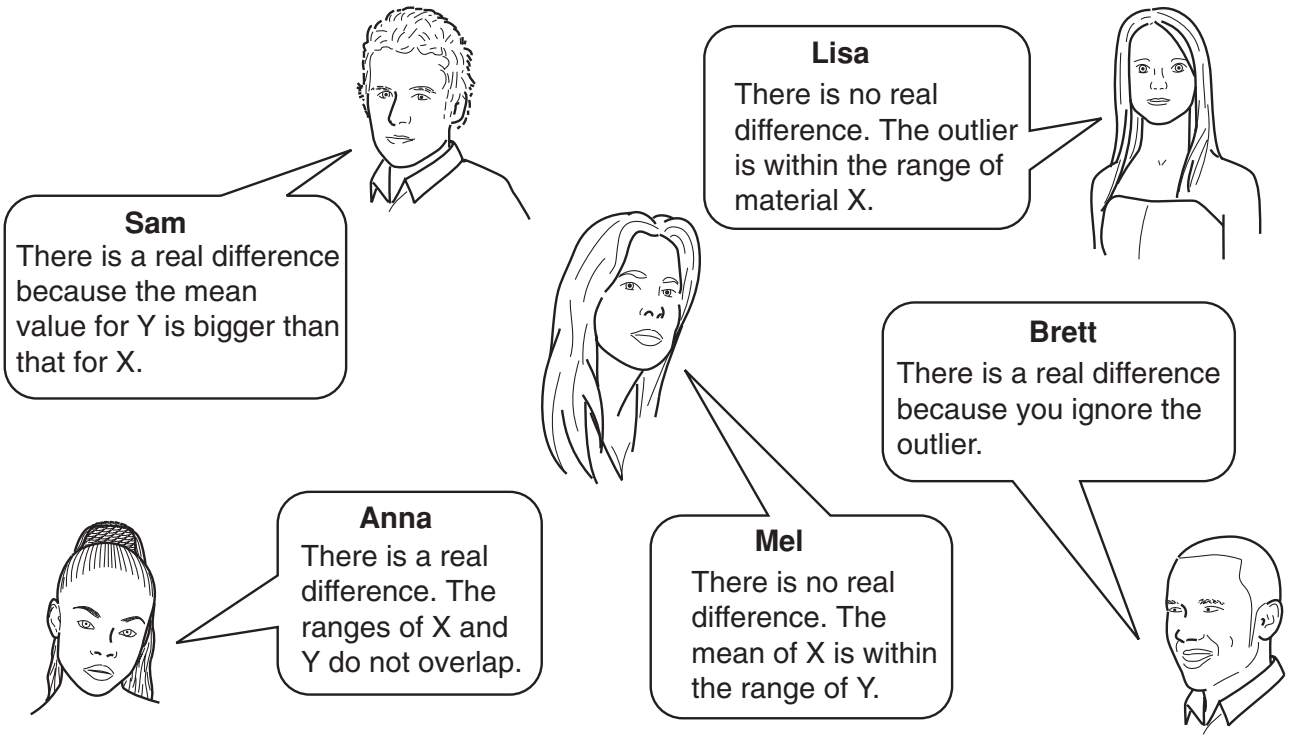
(c) Complete the table below to show the range of hardness number for material X.

	range
Range for X	

[1]

(d) Five students are discussing whether there is a **real difference** in the hardness of the two materials.

Here is what they say.



Who is giving the right answer **and** the right explanation for this answer?

..... [1]

[Turn over

(e) Material Y is a polymer with cross-links in it.

These cross-links make the polymer stronger.

(i) Which of the following statements explains this?

Put a tick (✓) in the box next to the correct answer.

Larger atoms are used to make the cross-links.	☐
The polymer molecules slide over each other more easily.	☐
Cross-links make the polymer molecules longer.	☐
The polymer molecules cannot slide past each other.	☐

[1]

(ii) Cross-linking also gives the polymer a higher melting point.

Which **two** of the following statements can be **put together** to explain this?

Put ticks (✓) in the boxes next to the **two** correct answers.

Cross-links make strong forces inside molecules.	☐
Cross-links make strong forces between molecules.	☐
More energy is needed to break up each polymer molecule.	☐
Cross-links put different atoms into polymer molecules.	☐
More energy is needed to break the polymer molecules apart from each other.	☐

[1]

[Total: 8]

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Question 6 starts on page 14.

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6 Read this article from a national newspaper.

There will be no more blue Smarties

The manufacturer is removing all artificial colours from Smarties. There is no natural alternative to the blue chemical used now.

The blue will be replaced by a white Smartie.

A recent study showed a possible harmful effect on the nervous system due to artificial colours and chemicals.

The blue colouring may cause hyperactivity and skin rashes. It is also listed as a cancer risk by the US Environmental Protection Agency.

A scientist said 'It is great news for children's health. We would now like to see the Government announce a total ban on the blue colouring.'

(a) Why are blue Smarties no longer being made?

Put a tick (✓) in the box next to the **best** answer.

Eating a blue Smartie will give all children a rash. ☐

All children who eat blue Smarties will develop health problems. ☐

The blue colouring may make some children hyperactive. ☐

All artificial additives will harm children. ☐ [1]

(b) Why would the scientist like to see the Government ban the blue colour?

Put a tick (✓) in the box next to the **best** answer.

To stop blue Smarties from being made. ☐

The blue colour is used in other foods. ☐

So the risk can be measured. ☐

To make Smarties cheaper. ☐

To reduce the risk to children's health. ☐ [1]

(c) Here are three statements about food additives.

Put ticks (✓) in the correct boxes to show whether each statement is **true** or **false**.

	true	**false**
Additives with an E number have passed a safety test.		
Preservatives slow down the growth of microbes.		
All natural additives are harmless.		

[2]

[Total: 4]

7 The Government is worried about the increase in childhood obesity.
The number of 2 to 11 year olds who are obese has risen steadily over the past 10 years, and there is a known link between obesity and type 2 diabetes.

(a) Politicians want to pass laws to help reduce childhood obesity.
The lists show some possible **actions** by the Government and the **results** they hope to achieve.
Draw a straight line from each **action** to the matching **result.**

action	result
	children won't know it is available.
banning chocolate machines from schools	
	children will get better food at home.
banning junk food advertising	
	no-one will be able to buy unhealthy food from shops.
educating new parents on nutrition	
	at least one meal a day will be of good standard.
setting nutritional standards for school dinners	
	these foods will be less easily available.

[3]

(b) Being overweight is a leading risk factor for type 2 diabetes.

(i) What information do you need to find the real risks of children developing type 2 diabetes?

Put ticks (✓) in the boxes next to the correct answers.

The chance of overweight children becoming overweight adults. ☐

The chance of diabetes occurring in overweight children. ☐

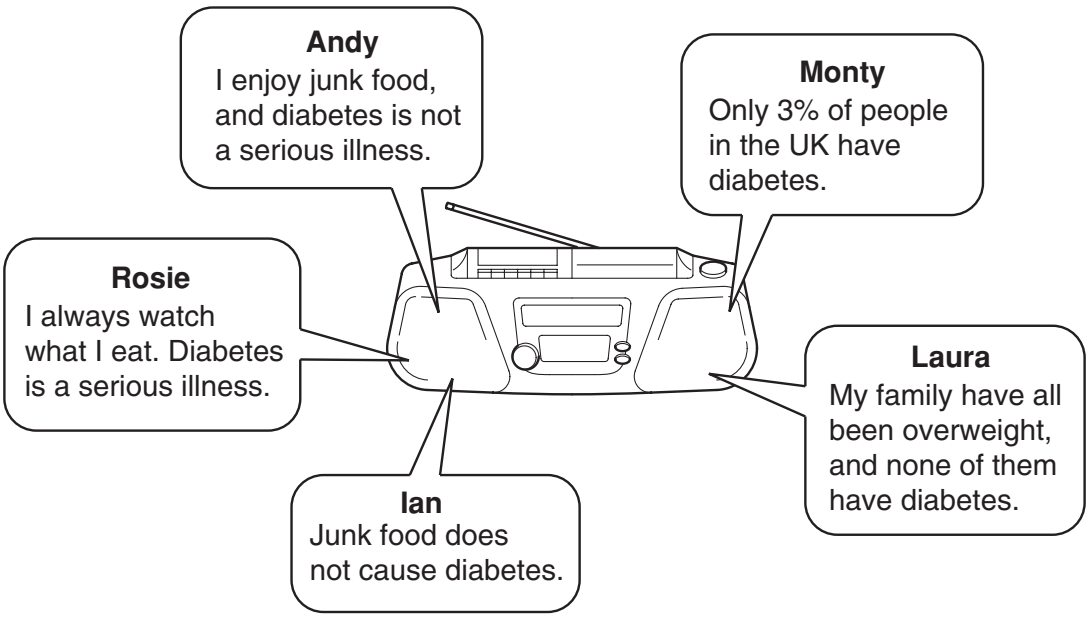
The consequences of being diabetic. ☐

The exercise habits of children. ☐

[2]

(ii) Five people are interviewed on a radio programme about their health and diet.

Here is what they say.



Which people are giving a reason to accept the risk of eating a poor diet?

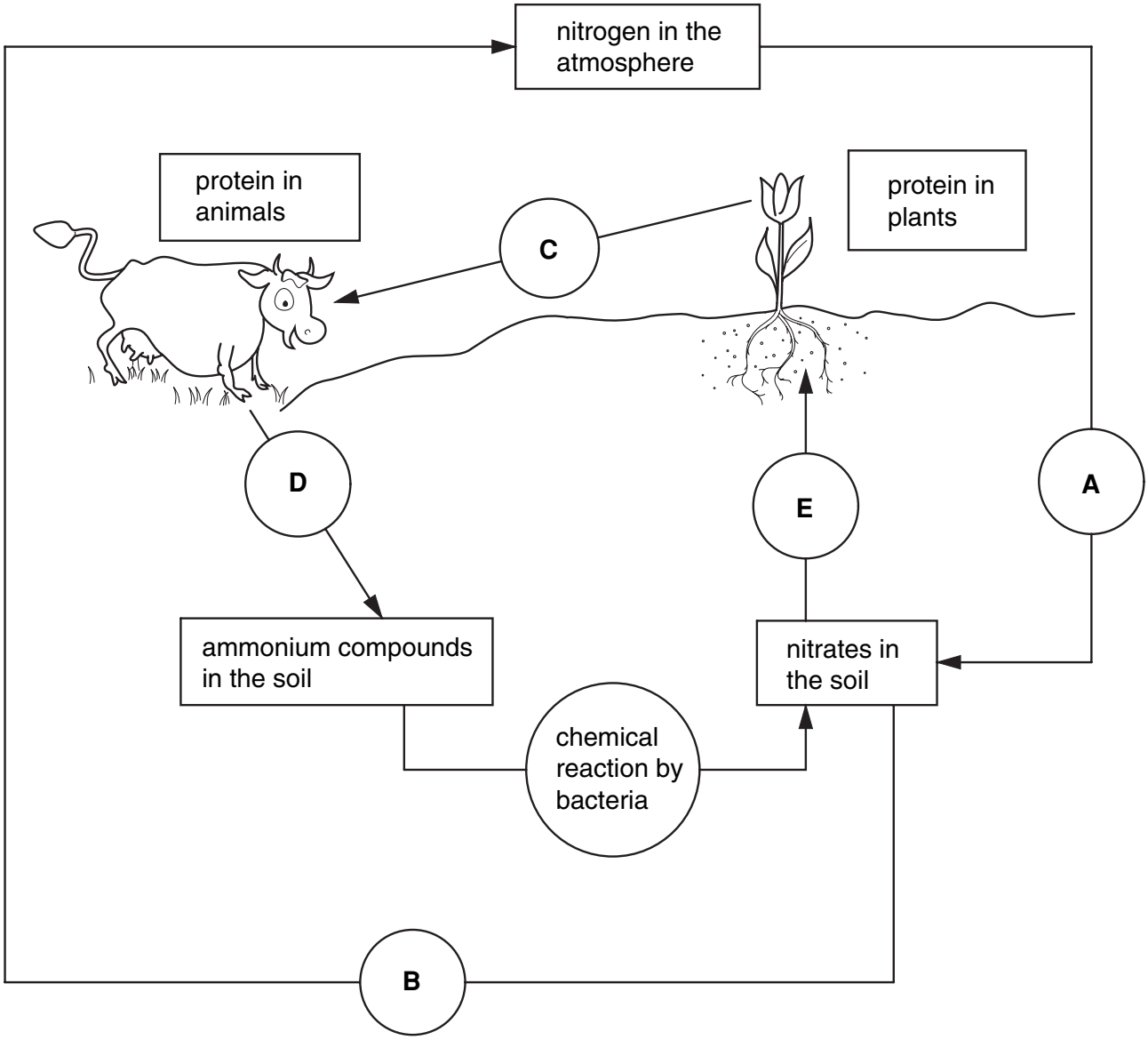
answer …… and …… [2]

[Total: 7]

[Turn over

8 This question is about the nitrogen cycle.

A simplified diagram of the nitrogen cycle is shown below.



A, **B**, **C**, **D** and **E** are all processes in the cycle of nitrogen atoms on the earth.

(a) Write down the letters of **two** processes in the cycle which involve the formation of amino acids.

answer ..... and ..... [2]

(b) Process **A** shows nitrogen being taken from the air and put into the ground.

In which **two** ways can this happen?

Put ticks (✓) in the boxes next to the **two** correct answers.

Bacteria in the soil that turn nitrates into nitrogen.	☐
Bacteria in the roots of some plants.	☐
Lightning.	☐
Decomposition.	☐

[1]

[Total: 3]

END OF QUESTION PAPER

Answer **all** the questions.

1 Elements in Group 7 are called the halogens. The table gives some information about the physical properties of three of the halogens.

halogen	proton number	melting point in °C	boiling point in °C	state at 25 °C	colour
chlorine	17	–101	–35	gas	pale green
bromine	35	–7	59		deep red
iodine	53	114	184		dark grey

(a) (i) Finish the table by writing the **state** for bromine **and** iodine in the empty boxes. [1]

(ii) The halogens show trends in physical properties with increasing proton number.

Finish this sentence about the trend in melting point.

Use information from the table to help you answer this question.

As the proton number …… the melting point …… . [1]

(b) The halogens also show a trend in reactivity.

This can be shown by the displacement reactions when halogens are added to solutions of halides.

A student made the following observations.

- When chlorine is added to potassium bromide solution, red bromine appears.
- When bromine is added to potassium iodide solution, brown iodine appears.
- When bromine is added to potassium chloride solution, there is no displacement.

(i) Use this information to place these three halogens in order of reactivity.

most reactive .....

.....

least reactive ..... [2]

(ii) Fluorine is a halogen with proton number 9.

Which statement describes the displacement reactions of fluorine?

Put a tick (✓) in the box next to the correct answer.

Fluorine displaces chlorine, bromine and iodine. ☐

Fluorine displaces iodine but not chlorine or bromine. ☐

Fluorine displaces chlorine and bromine but not iodine. ☐

Fluorine displaces bromine and iodine but not chlorine. ☐

[1]

(c) Bromine forms ions with the formula Br^-.

Bromine reacts with strontium to form strontium bromide, $SrBr_2$.

Use this information to work out the formula of a strontium ion.

..... [1]

[Total: 6]

2 This diagram shows part of the Periodic Table.

						He
Li	Be		C			Ne
Na	Mg				C*l*	Ar
K	Ca				Br	

(a) (i) Write down the symbol **and** name of an element in the same **period** as calcium.

symbol ..... name ..... [1]

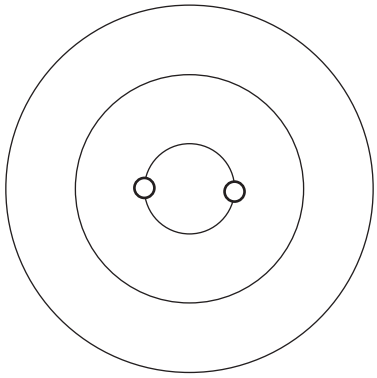
(ii) Write down the symbol **and** name of an element in the same **group** as neon.

symbol ..... name ..... [1]

(iii) Finish the diagram to show the arrangement of electrons in an atom of **argon**.

Use a circle ○ to show the position of each electron.

The positions of two electrons have already been drawn on the diagram to help you.



[1]

(b) The elements sodium and chlorine react to form the compound sodium chloride, NaC*l*.

(i) Write a balanced symbol equation for the reaction between sodium and chlorine.

Include state symbols in your equation.

..... [3]

(ii) Sodium chloride is made of sodium ions, Na^+, and chloride ions, Cl^-.

Which statement describes evidence that sodium chloride is made of ions?

Put a tick (✓) in the box next to the correct answer.

Sodium chloride is a solid. ☐

Sodium chloride is made of crystals. ☐

Sodium chloride has a high melting point. ☐

Molten sodium chloride conducts electricity. ☐

[1]

(iii) The table shows the arrangement of electrons in sodium atoms and chlorine atoms.

Complete the table to show the arrangement of electrons in sodium ions and chloride ions.

sodium atom Na	**sodium ion Na^+**	**chlorine atom Cl**	**chloride ion Cl^-**
2.8.1		2.8.7	

[2]

[Total: 9]

3 The table gives information about ions dissolved in sea water.

ion	symbol	percentage by mass of the total dissolved solids (%)
chloride	Cl^-	55
sodium	Na^+	30
sulfate	SO_4^{2-}	8
magnesium	Mg^{2+}	4
calcium	Ca^{2+}	1
potassium	K^+	1
carbonate	CO_3^{2-}	0.5
bromide	Br^-	0.2

These ions enter the sea water when crystals of ionic compounds in rocks dissolve.

Each of these ionic compounds is made up of one type of positive ion and one type of negative ion shown in the table.

(a) (i) One compound that dissolved from the rocks into the water is magnesium sulfate.

Suggest the name and formula of one **other** ionic compound that dissolved from the rocks into the water.

Use information from the table to help you.

name ..... formula ..... [2]

(ii) When a sample of sea water is evaporated to dryness, a white solid is left. This is a mixture of several ionic compounds.

Look at the **percentage by mass of the total dissolved solids** column in the table.

Use the information to name the ionic compound that makes up **most** of the white solid.

..... [1]

(b) Sea water conducts electricity.

Which statements give the best explanation for this?

Put a tick (✓) in the box next to **each** correct explanation.

Ions are able to move around in the sea water.	☐
Electrons can pass from ion to ion in the sea water.	☐
The sea water contains more ions with positive charges than ions with negative charges.	☐
The sea water contains ions that have positive charges and ions that have negative charges.	☐

[1]

(c) Solid ionic compounds form crystals.

Finish the sentence about these crystals by choosing words from the list.

atoms **attraction** **ions** **molecules**

opposite **positive** **repulsion** **similar**

In the crystals of solid ionic compounds, particles called …… are held together by the force of …… between particles with …… charges. [1]

(d) Solid ionic compounds have giant, three-dimensional structures.

Which of the following properties are shown by most **solid** ionic compounds?

Put a tick (✓) in the box next to **each** correct answer.

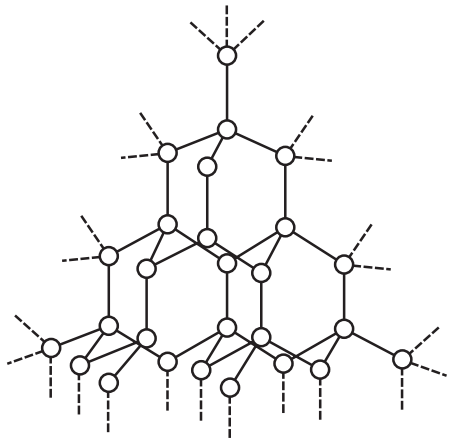
low density	☐
high flexibility	☐
high reactivity	☐
highly coloured	☐
high melting point	☐
low electrical conductivity	☐

[1]

[Total: 6]

[Turn over

4 Diamond is a giant structure of carbon atoms with bonding similar to that in silicon dioxide.



(a) Here are some sentences about **diamond**.

Finish these sentences by putting a tick (✓) in the box next to the correct word in each pair.

The carbon atoms are joined by

ionic	
covalent	

bonds.

Each carbon atom is joined to

four	
three	

others.

This structure gives diamond a very

low	
high	

melting point,

low	
high	

solubility in water and

low	
high	

electrical conductivity.

[3]

(b) Living things are made up from compounds **mainly** containing four elements.

One of these elements is **carbon**.

What are the names of the **other three** elements?

1.....

2.....

3..... [1]

[Total: 4]

5 The ore haematite contains iron(III) oxide. Iron is extracted from this ore by reaction with carbon.

The products of this reaction are iron and carbon dioxide.

(a) Finish this **symbol** equation for the reaction.

..... Fe_2O_3 + ... C $\rightarrow$ ..... + ... [2]

(b) A haematite ore contains 80% by mass of iron(III) oxide.

Calculate the maximum mass of iron that can be extracted from each tonne of this ore.

Show each step of your calculation as indicated below.

(1 tonne = 1000 kg)

(relative atomic mass, A_r: Fe = 56, O = 16)

mass of iron(III) oxide in 1 tonne of haematite = ... kg

formula mass of iron(III) oxide = ...

mass of iron in 1 tonne of haematite = ... kg [3]

[Total: 5]

6 An acid and an alkali react to form a salt and water.

$$\text{acid} + \text{alkali} \longrightarrow \text{salt} + \text{water}$$

(a) Draw straight lines to join up the boxes to show which **acid** reacts with which **alkali** to make each **salt**.

acid	**alkali**	**salt**
sulfuric acid	potassium hydroxide	
		sodium sulfate
hydrochloric acid	ammonium hydroxide	
		potassium chloride
nitric acid	sodium hydroxide	
		magnesium nitrate
phosphoric acid	magnesium hydroxide	

[3]

(b) **(i)** What is the formula of the **ion** produced when any **acid** dissolves in water?

..... [1]

(ii) What is the formula of the **ion** produced when any **alkali** dissolves in water?

..... [1]

(iii) Write the equation for the neutralisation reaction between these two ions.

..... [1]

[Total: 6]

7 Magnesium sulfate is one of the chemicals in detergent powder.

Mary makes some magnesium sulfate using this reaction.

magnesium carbonate + sulfuric acid → magnesium sulfate + water + carbon dioxide

$MgCO_3$ + H_2SO_4 → $MgSO_4$ + H_2O + CO_2

(a) (i) The theoretical yield for Mary's experiment is 12.0 g.

Mary dries and weighs the magnesium sulfate she makes. This is her actual yield.

Actual yield = 10.8 g.

Work out the percentage yield for Mary's experiment.

percentage yield = ... [1]

(ii) The relative formula mass of magnesium carbonate is 84.

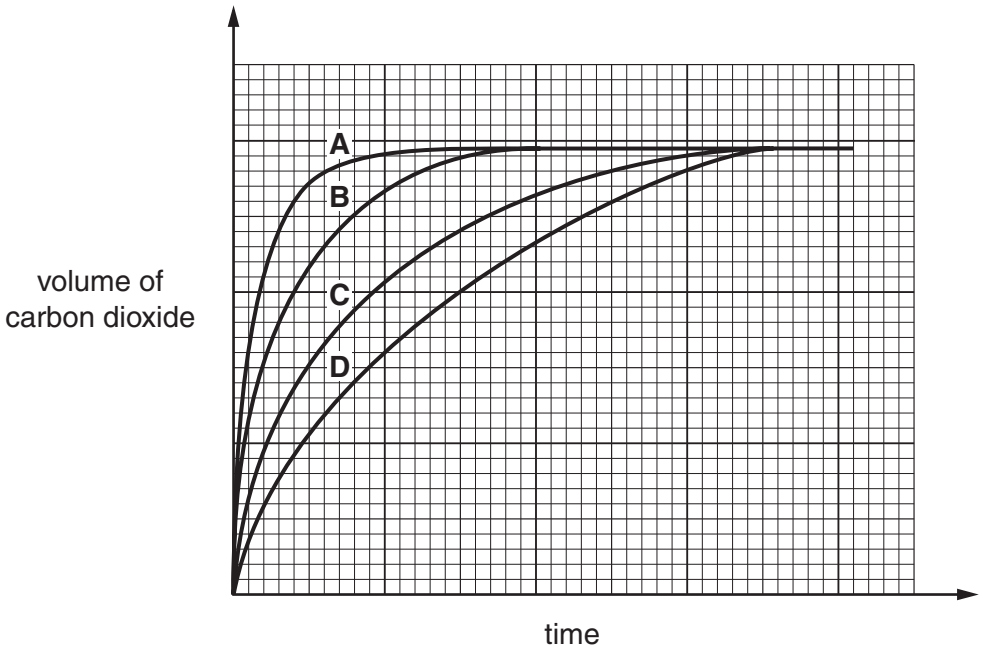
The relative formula mass of magnesium sulfate is 120.

Calculate the mass of magnesium carbonate that must react with sulfuric acid to make the theoretical yield of 12.0 g of magnesium sulfate.

mass of magnesium carbonate = ... g [1]

(b) Mary investigates the rate of this reaction with different sized lumps of magnesium carbonate. She keeps all other conditions constant.

She measures the volume of carbon dioxide given off at time intervals and plots her results on a grid.



(i) Which line, **A**, **B**, **C** or **D**, shows results from:

the fastest rate of reaction?

answer .....

the largest lumps of magnesium carbonate?

answer .....[1]

(ii) In each of the four experiments Mary used 100 cm^3 of solution containing 1.0 g sulfuric acid.

Mary now repeats the experiments, but changes the amount of sulfuric acid.

For each change put a tick (✓) in the correct box to show whether the reaction would be slower, the same speed, or faster.

	slower	**same speed**	**faster**
100 cm^3 solution containing 2.0 g sulfuric acid	☐	☐	☐
100 cm^3 solution containing 0.5 g sulfuric acid	☐	☐	☐
200 cm^3 solution containing 2.0 g sulfuric acid	☐	☐	☐
200 cm^3 solution containing 1.0 g sulfuric acid	☐	☐	☐
50 cm^3 solution containing 0.5 g sulfuric acid	☐	☐	☐

[3]

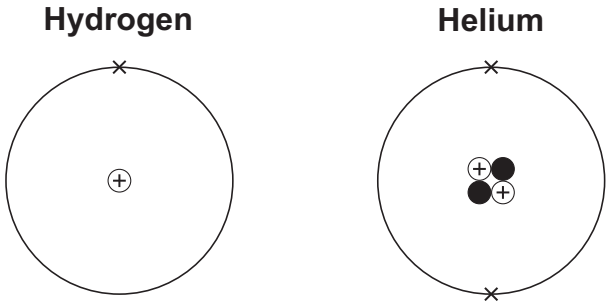
[Total: 6]

END OF QUESTION PAPER

Do not write outside the box

Answer **all** questions in the spaces provided.

1 The Sun produces helium atoms from hydrogen atoms by nuclear fusion reactions.



1 (a) Describe the differences in the atomic structures of a hydrogen atom and a helium atom.

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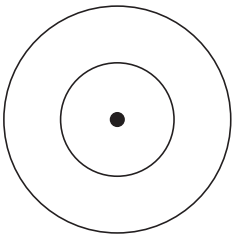
(3 marks)

1 (b) The Sun consists of 73% hydrogen and 25% helium.
The rest is other elements.
One of the other elements in the Sun is neon.

Use the Chemistry Data Sheet to help you to answer these questions.

1 (b) (i) Complete the diagram to show the electronic structure of a neon atom.



(1 mark)

1 (b) (ii) Why is neon in the same group of the periodic table as helium?

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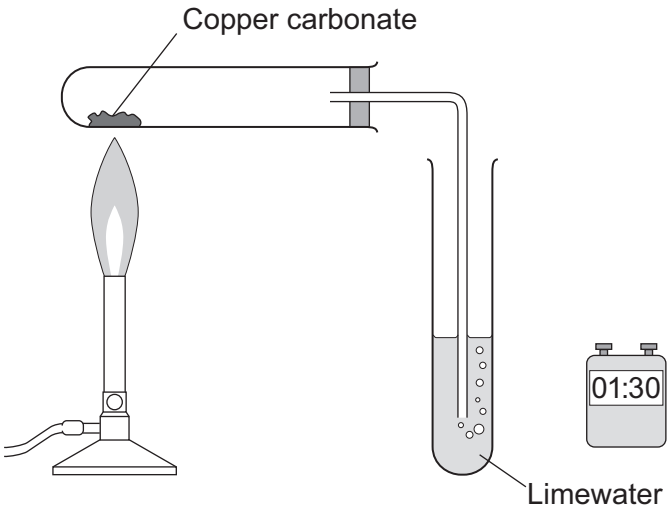
(1 mark)

5

Turn over for the next question

2 Carbon dioxide is produced when copper carbonate is heated.

A student investigated heating copper carbonate.
The student used the apparatus to measure how long it took for carbon dioxide to be produced.
The student also noted what happened during each minute for three minutes.



2 (a) The student used changes to the limewater to measure how long it took for carbon dioxide to be produced.

Describe how.

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(2 marks)

2 (b) The student wrote down her observations.

Time interval in minutes	Observations
Between 0 and 1	A slow release of gas bubbles. The limewater did not change. The solid in the test tube was green.
Between 1 and 2	A fast release of gas bubbles. The limewater changed at 1 minute 10 seconds.
Between 2 and 3	No release of gas bubbles. The solid in the test tube was black.

2 (b) (i) Suggest the reason for the student's observations between 0 and 1 minute.

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(2 marks)

2 (b) (ii) Explain the student's observations between 1 and 2 minutes.

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(2 marks)

2 (b) (iii) Explain the student's observations between 2 and 3 minutes.

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(2 marks)

8

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

3 This question is about oil reserves.

3 (a) Diesel is separated from crude oil by fractional distillation.

Describe the steps involved in the fractional distillation of crude oil.

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(3 marks)

3 (b) Diesel is a mixture of lots of different *alkanes.*

What are *alkanes*?

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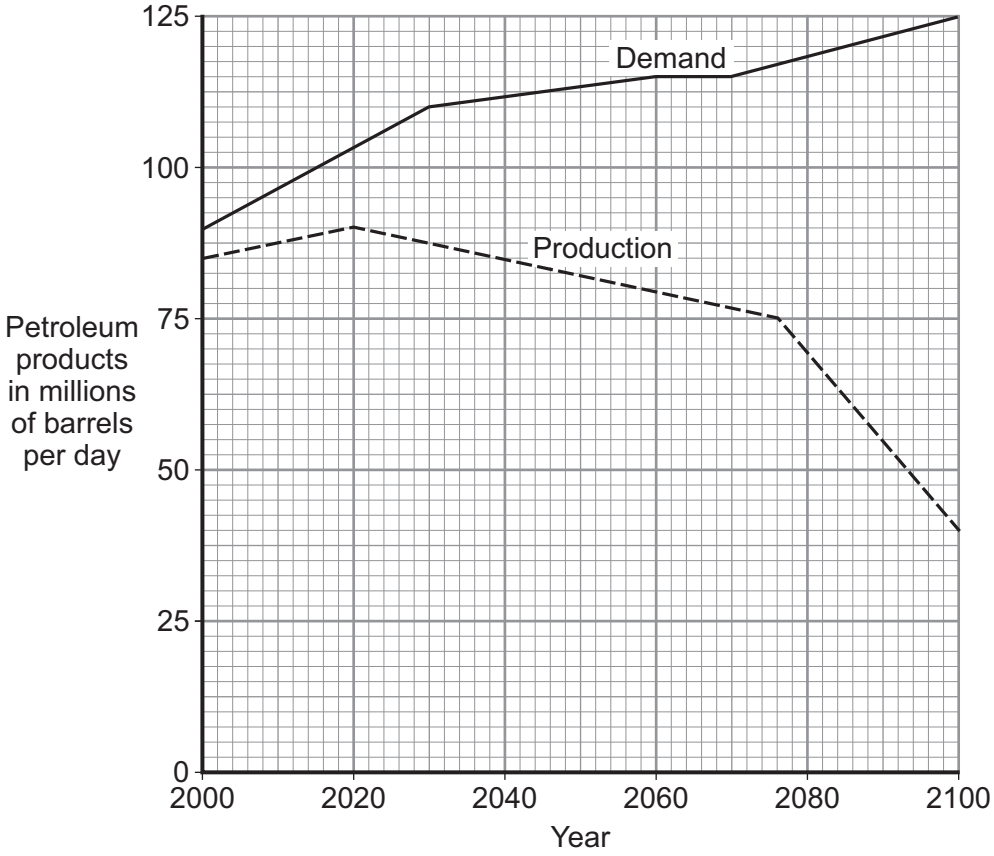
(2 marks)

Question 3 continues on the next page

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

Petroleum products, such as petrol, are produced from crude oil.
The graph shows the possible future production of petroleum products from crude oil and the expected demand for petroleum products.



Canada's oil sands hold about 20% of the world's known crude oil reserves.

The oil sands contain between 10 to 15% of crude oil. This crude oil is mainly bitumen.

In Canada the oil sands are found in the ground underneath a very large area of forest. The trees are removed. Then large diggers and trucks remove 30 metres depth of soil and rock to reach the oil sands. The oil sands are quarried. Boiling water is mixed with the quarried oil sands to separate the bitumen from the sand. Methane (natural gas) is burned to heat the water.

The mixture can be separated because bitumen floats on water and the sand sinks to the bottom of the water. The bitumen is cracked and the products are separated by fractional distillation.

Use the information on page 8 and your knowledge and understanding to suggest the advantages and disadvantages of extracting petroleum products from oil sands.

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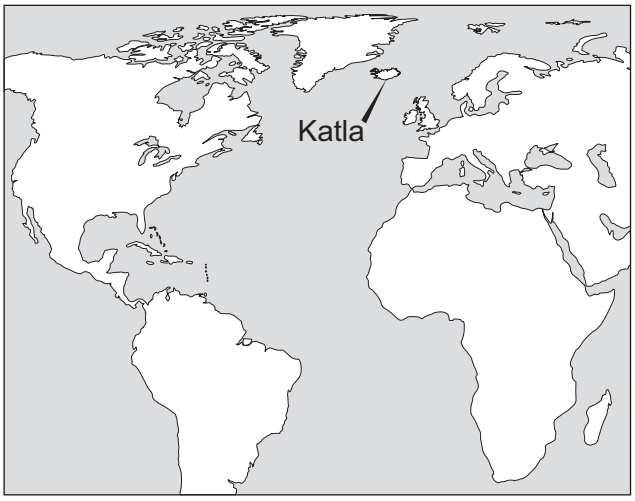
(6 marks)

11

4 Iceland has many volcanoes.

4 (a) Scientists are monitoring a volcano in Iceland, called Katla.
There has been an increase in the number of tremors (small earthquakes) in this area.



4 (a) (i) Why does Iceland have volcanoes?

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(1 mark)

4 (a) (ii) Scientists predict that Katla may erupt soon.
However, scientists do **not** know exactly when Katla will erupt.

Suggest **one** reason why.

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(1 mark)

4 (b) During the first billion years of the Earth's existence its surface was covered with volcanoes.

Describe how this volcanic activity led to the formation of oceans.

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(2 marks)

4 (c) The Earth has about 500 000 earthquakes each year.

Describe how activity within the Earth results in earthquakes.

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(3 marks)

7

Turn over for the next question

5 Olive oil has a melting point of –6 °C and a boiling point of 300 °C.
Olive oil has a high content of healthy, unsaturated fats.

5 (a) Olive oil can be hardened by reacting it with hydrogen.

5 (a) (i) State the conditions needed for this reaction.

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(2 marks)

5 (a) (ii) A student said that hardening would make olive oil healthier.

Is this student's hypothesis correct?

Explain your answer in terms of what happens in the hardening process.

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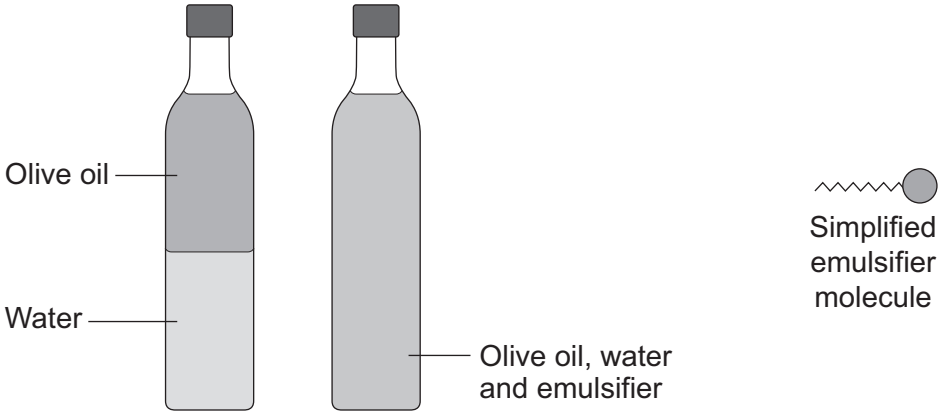
(2 marks)

5 (b) Olive oil and water do not mix.
A salad dressing is made by shaking olive oil and water with an emulsifier.



Explain how these emulsifier molecules are able to produce a stable mixture after shaking olive oil and water.

Use the diagram of the simplified emulsifier molecule to help you to answer this question.

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(3 marks)

7

Turn over for the next question

6 Most petrol used in cars contains about 5% ethanol (C_2H_5OH).

6 (a) The complete combustion of ethanol produces carbon dioxide and water.

Complete and balance the symbol equation for the complete combustion of ethanol.

C_2H_5OH + ...O_2 → ..... + ...

(2 marks)

6 (b) Ethanol can be produced from octane (C_8H_{18}).
The two chemical equations represent the production of ethanol from octane.

Equation 1: $C_8H_{18} \rightarrow C_4H_{10} + 2C_2H_4$

Equation 2: $C_2H_4 + H_2O \rightarrow C_2H_5OH$

6 (b) (i) In **Equation 1** the products are a mixture of two gases.

Describe a chemical test that would indicate the presence of ethene (C_2H_4) in the mixture.

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(2 marks)

6 (b) (ii) Describe, as fully as you can, the conditions used for the two reactions to produce ethanol from octane.

Use **Equation 1** and **Equation 2** to help you with your answer.

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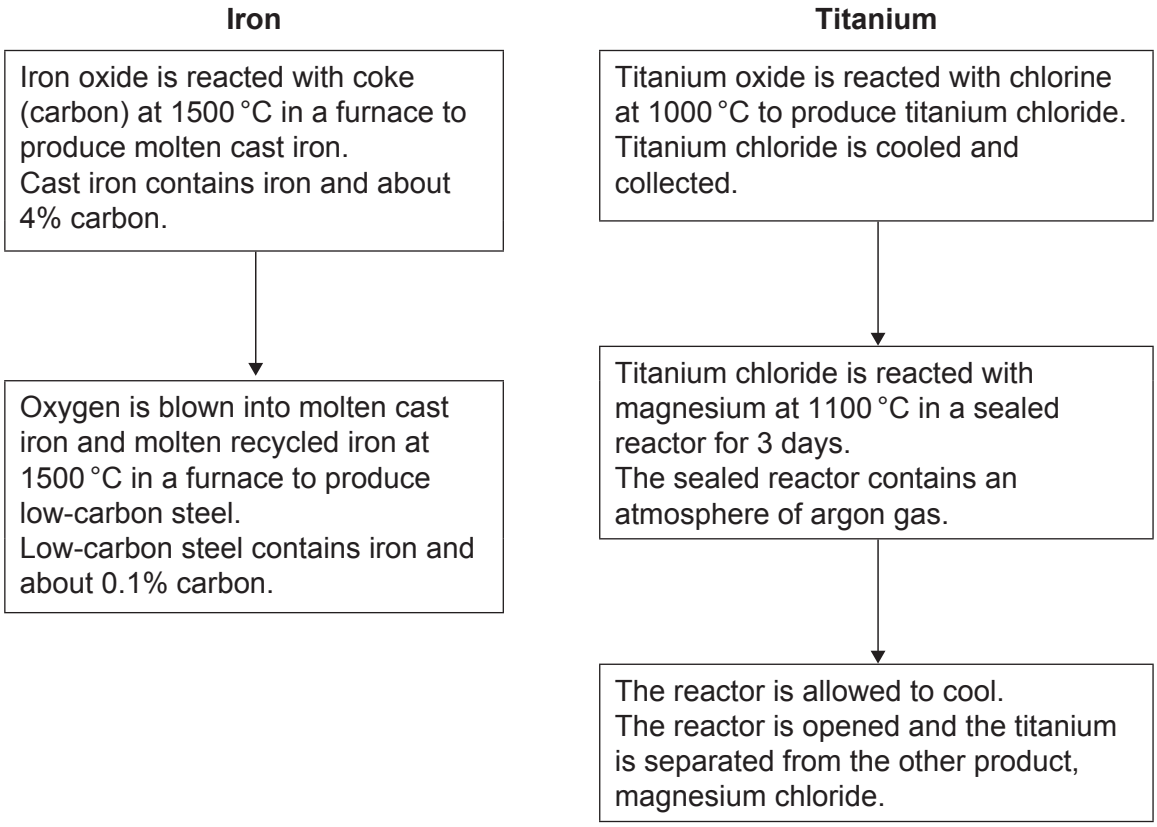
(4 marks)

8

Turn over for the next question

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

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



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

Explain why.

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(3 marks)

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

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

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

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(3 marks)

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

A chemical reaction in the production of iron is:

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

A chemical reaction in the production of titanium is:

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

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

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

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

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

Explain your answer.

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(2 marks)

8

8 Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere may have evolved.

Titan is the largest moon of Saturn.

The table shows data about some substances in the atmosphere of Titan.

Substance	Melting point in °C	Boiling point in °C
Nitrogen	–210	–196
Methane	–183	–164
Argon	–189	–186
Hydrogen	–259	–253
Carbon monoxide	–205	–192

8 (a) There is no water on Titan. The average surface temperature on Titan is –179 °C.

Which of the substances in the table would form oceans on Titan?

Explain your answer.

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(2 marks)

8 (b) Amino acids are essential to life.

In the 1950s the Miller-Urey experiment showed that simple amino acids, such as glycine (NH_2CH_2COOH), could have been produced from the Earth's early atmosphere.

The Miller-Urey experiment showed that simple amino acids could be produced by reactions between hydrocarbons, ammonia and water.

Explain how the Miller-Urey experiment suggests that reactions between the substances in Titan's atmosphere could also produce simple amino acids.

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(4 marks)

6

END OF QUESTIONS

Do not write outside the box

Answer **all** questions in the spaces provided.

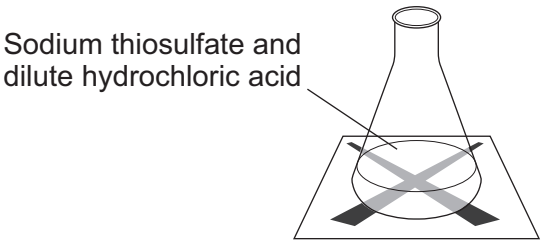
1 A student investigated the rate of reaction between sodium thiosulfate and dilute hydrochloric acid.

The student placed a conical flask over a cross on a piece of paper.

The student mixed the solutions in the flask.

The solution slowly went cloudy.

The student timed how long it took until the cross could not be seen.



The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

sodium thiosulfate	+	hydrochloric acid	→	sodium chloride	+	water	+	sulfur dioxide	+	sulfur

1 (a) Explain why the solution goes cloudy.

.....

.....

.....

.....

(2 marks)

1 (b) The student repeated the experiment with different concentrations of sodium thiosulfate.

Concentration of sodium thiosulfate in moles per dm^3	Time taken until the cross could not be seen in seconds			
	Trial 1	Trial 2	Trial 3	Mean
0.040	71	67	69	69
0.060	42	45	45	44
0.080	31	41	33	

1 (b) (i) Calculate the mean time for 0.080 moles per dm^3 of sodium thiosulfate.

.....

.....

.....

Mean = ... seconds

(2 marks)

1 (b) (ii) Describe and explain, in terms of particles and collisions, the effect that increasing the concentration of sodium thiosulfate has on the rate of the reaction.

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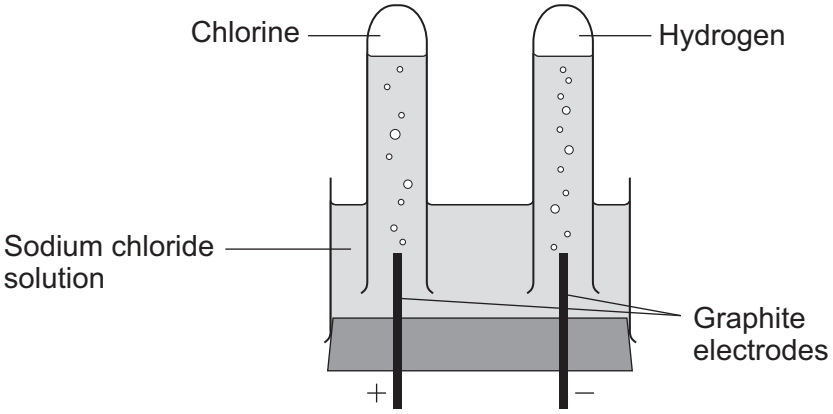
(3 marks)

7

Turn over for the next question

2 The electrolysis of sodium chloride solution is an industrial process.

The diagram shows the apparatus used in a school experiment.



2 (a) One of the products of the electrolysis of sodium chloride solution is hydrogen.

2 (a) (i) Why do hydrogen ions move to the negative electrode?

.....

.....

(1 mark)

2 (a) (ii) How does a hydrogen ion change into a hydrogen atom?

.....

.....

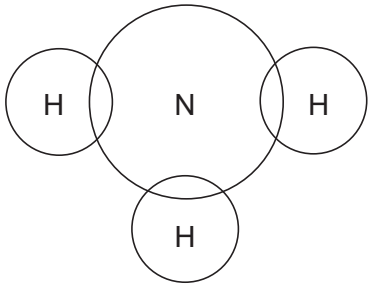
(1 mark)

2 (b) Hydrogen is used to make ammonia (NH_3).

Complete the diagram to show the bonding in ammonia.

Use dots (●) and crosses (x) to show electrons.

Show only outer shell electrons.



(2 marks)

2 (c) The table shows the ions in sodium chloride solution.

Positive ions	Negative ions
hydrogen	chloride
sodium	hydroxide

In industry, some of the waste from the electrolysis of sodium chloride solution is alkaline and has to be neutralised.

2 (c) (i) Which ion makes the waste alkaline?

.....

(1 mark)

2 (c) (ii) This waste must be neutralised.

Write the ionic equation for the neutralisation reaction.

.....

(1 mark)

Question 2 continues on the next page

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

The electrolysis of sodium chloride solution also produces chlorine and sodium hydroxide.

In industry, the electrolysis of sodium chloride solution can be done in several types of electrolysis cell.

Some information about two different types of electrolysis cell is given below.

	Mercury cell	**Membrane cell**
Cost of construction	Expensive	Relatively cheap
Additional substances used	Mercury, which is recycled. Mercury is toxic so any traces of mercury must be removed from the waste.	Membrane, which is made of a polymer. The membrane must be replaced every 3 years.
Amount of electricity used for each tonne of chlorine produced in kWh	3400	2950
Quality of chlorine produced	Pure	Needs to be liquefied and distilled to make it pure.
Quality of sodium hydroxide solution produced	50% concentration. Steam is used to concentrate the sodium hydroxide solution produced.	30% concentration. Steam is used to concentrate the sodium hydroxide solution produced.

Use the information and your knowledge and understanding to compare the environmental and economic advantages and disadvantages of these **two** types of electrolysis cell.

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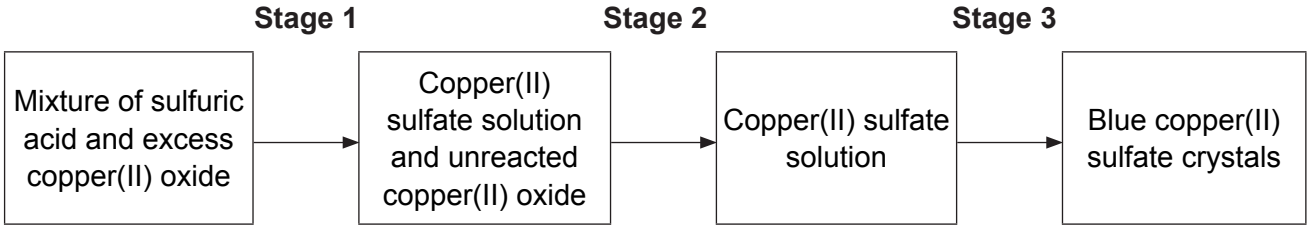
(6 marks)

12

3 This question is about compounds of copper.

3 (a) A student made some copper(II) sulfate crystals.

The flow diagram shows the stages of the preparation of copper(II) sulfate crystals.



3 (a) (i) The reaction mixture is heated in **Stage 1**.

Suggest why.

.....

.....

(1 mark)

3 (a) (ii) Complete the equation for this reaction.

CuO + ... → $CuSO_4$ + ...

(2 marks)

3 (a) (iii) How would the student remove the unreacted copper(II) oxide in **Stage 2**?

.....

.....

(1 mark)

3 (a) (iv) How would the student obtain copper(II) sulfate crystals from the copper(II) sulfate solution in **Stage 3**?

.....

(1 mark)

3 (a) (v) The mass of crystals obtained was less than the student had calculated.

Suggest **one** reason why.

.....

.....

(1 mark)

3 (b) The student heated the blue copper(II) sulfate crystals.

The word equation for the reaction is shown below.

hydrated copper(II) sulfate $\rightleftharpoons$ anhydrous copper(II) sulfate + water

blue white

3 (b) (i) What does the symbol $\rightleftharpoons$ mean ?

.....

(1 mark)

3 (b) (ii) 300 J of energy are taken in when some blue copper(II) sulfate crystals are heated.

What is the energy change when an excess of water is added to the anhydrous copper(II) sulfate produced?

.....

.....

(2 marks)

3 (c) A sample of copper nitride contains 3.81 g of copper and 0.28 g of nitrogen.

Calculate the empirical formula.

You **must** show all your working to get full marks.

Relative atomic masses (A_r): N = 14; Cu = 63.5.

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Empirical formula = ...

(4 marks)

13

4 Thermosoftening polymers can be used to make plastic bottles and food packaging.

4 (a) The reaction to produce polymers uses a catalyst.

Why does the catalyst work for a long time before it needs replacing?

.....

.....

(1 mark)

4 (b) Thermosoftening polymers would **not** be suitable for packaging very hot food.

Explain why in terms of their properties and structure.

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(2 marks)

4 (c) Compounds from food packaging must not contaminate the food.

Food can be tested for contamination using gas chromatography linked to mass spectroscopy (GC-MS).

4 (c) (i) Gas chromatography can separate substances in a mixture of compounds.

Describe how, as fully as you can.

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(3 marks)

4 (c) (ii) What information does the molecular ion peak give about the molecule?

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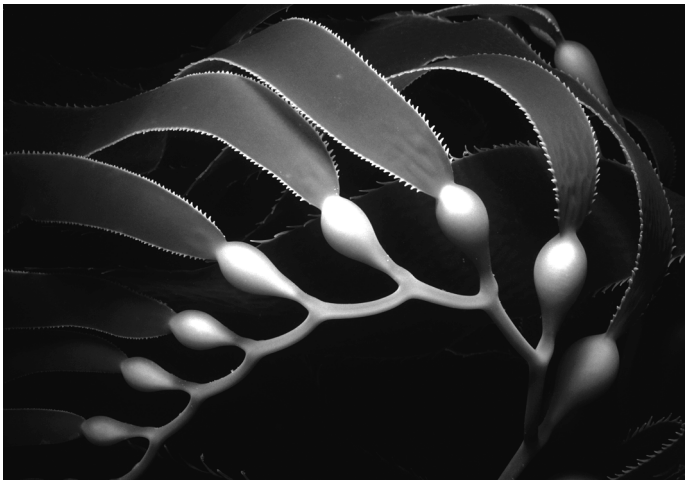
(1 mark)

7

Turn over for the next question

5 Kelp is a seaweed.

Kelp can be used in foods and as a renewable energy source.



5 (a) Scientific experiments, on their own, **cannot** fully answer one of the following questions. Which one?

Tick (✓) **one** box.

Questions	Tick (✓)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal?	
Will kelp last longer than coal as an energy source?	
Which fuel, kelp or coal, produces the most ash when burned?	

(1 mark)

5 (b) Scientists cannot answer the question 'should people use kelp instead of coal as an energy source?'

Give **two** reasons why.

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(2 marks)

5 (c) Sodium iodide can be produced from kelp.

5 (c) (i) How many electrons are in the outer shell of an iodine atom? ☐

(1 mark)

5 (c) (ii) Sodium iodide contains sodium ions (Na^+) and iodide ions (I^-).

Describe, as fully as you can, what happens when sodium atoms react with iodine atoms to produce sodium iodide.

You may use a diagram in your answer

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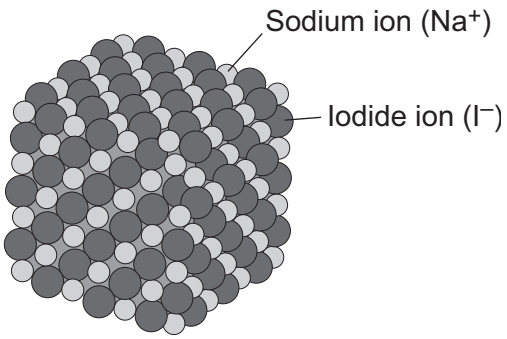
(3 marks)

Question 5 continues on the next page

5 (c) (iii) The diagram shows the structure of sodium iodide.



Solid sodium iodide does not conduct electricity.

Why does sodium iodide solution conduct electricity?

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(1 mark)

5 (c) (iv) When sodium iodide solution is electrolysed, iodine is formed at the positive electrode.

Complete and balance the half equation for the formation of iodine.

..... I^- $\rightarrow$ I_2 + ... e^-

(1 mark)

5 (c) (v) What is formed at the negative electrode when sodium iodide solution is electrolysed?

Explain why.

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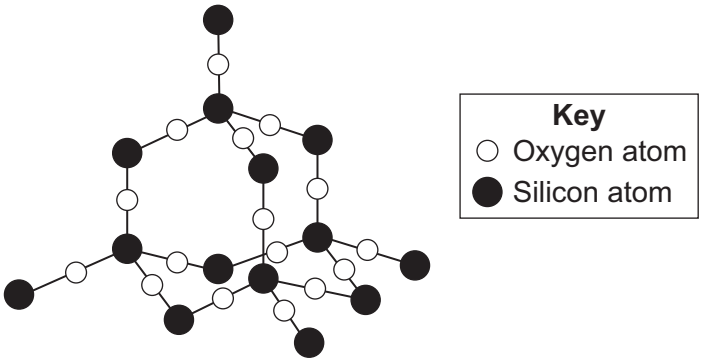
(2 marks)

11

6 Silicon dioxide is used as a lining for furnaces.

Furnaces can be used to melt iron for recycling.

The diagram shows a small part of the structure of silicon dioxide.



Explain why silicon dioxide is a suitable material for lining furnaces.

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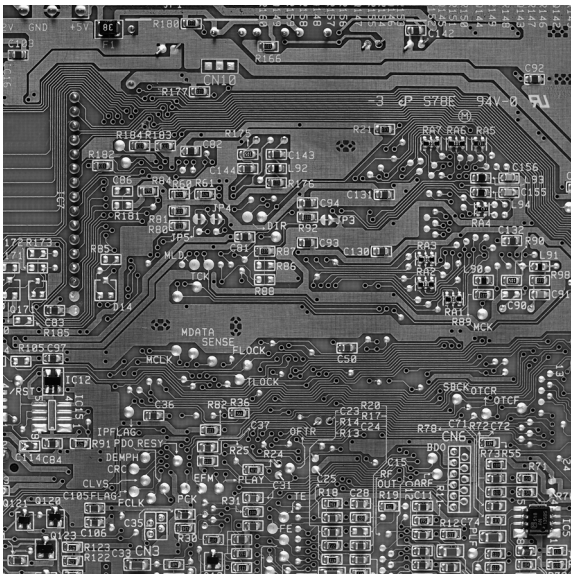
(4 marks)

4

7 Etching is a way of making printed circuit boards for computers.



Printed circuit boards are made when copper sheets are etched using iron(III) chloride solution. Where the copper has been etched, only plastic remains.

7 (a) Copper is a good conductor of electricity.

Explain why.

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(2 marks)

7 (b) Iron(III) chloride can be produced by the reaction shown in the equation:

$$2\,Fe + 3\,Cl_2 \rightarrow 2\,FeCl_3$$

7 (b) (i) Calculate the maximum mass of iron(III) chloride ($FeCl_3$) that can be produced from 11.20 g of iron.

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

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Maximum mass of iron(III) chloride = ... g

(3 marks)

7 (b) (ii) The actual mass of iron(III) chloride ($FeCl_3$) produced was 24.3 g.

Calculate the percentage yield.

(If you did not answer part (b)(i) assume that the maximum theoretical mass of iron(III) chloride ($FeCl_3$) is 28.0 g. This is **not** the correct answer to part (b)(i).)

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Percentage yield = ...%

(1 mark)

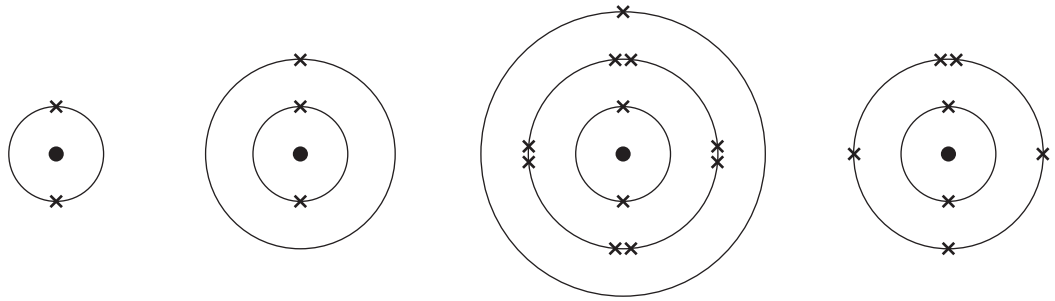
6

END OF QUESTIONS

Do not write outside the box

Answer **all** questions in the spaces provided.

1 The diagrams show the electronic structure of four different atoms.



Atom A **Atom B** **Atom C** **Atom D**

Use the Chemistry Data Sheet to help you to answer these questions.

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

.....

(1 mark)

1 (b) Why is there no overall electrical charge on each atom?

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(1 mark)

1 (c) Why is **Atom A** unreactive?

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(1 mark)

1 (d) Which **two** of these atoms have similar chemical properties?
Give a reason for your answer.

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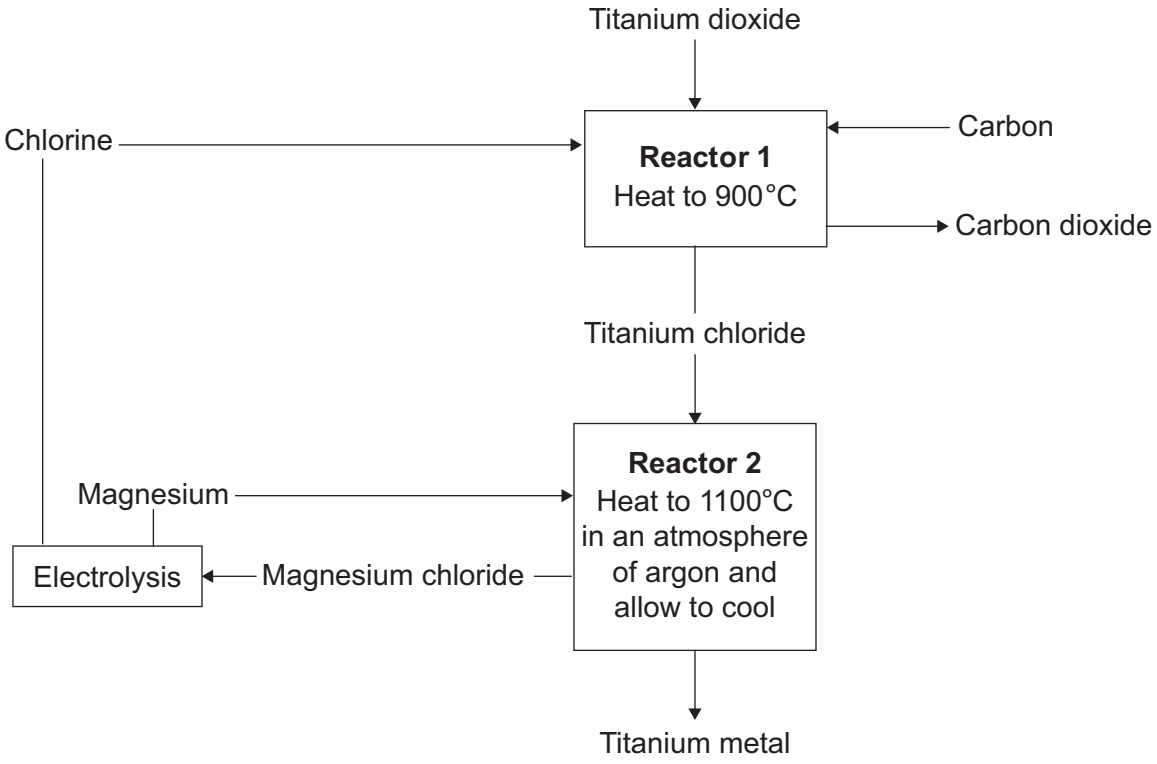
(2 marks)

5

2 Rutile is an ore of titanium. Rutile contains titanium dioxide.
The flow chart shows how titanium metal is extracted from titanium dioxide.



2 (a) Titanium is much more expensive than iron.

Give **one** reason why.

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(1 mark)

2 (b) Name the only waste product shown on the flow chart.

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(1 mark)

2 (c) Describe the example of recycling shown on the flow chart.

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(2 marks)

2 (d) The air is removed from **Reactor 2**. An atmosphere of argon is used for the reaction between titanium chloride and magnesium metal.

Explain why.

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(2 marks)

Question 2 continues on the next page

2 (e) Titanium metal is produced by reacting titanium chloride with magnesium.

950 kg of titanium chloride was mixed with 240 kg of magnesium metal. The mixture was heated and produced 950 kg of magnesium chloride.

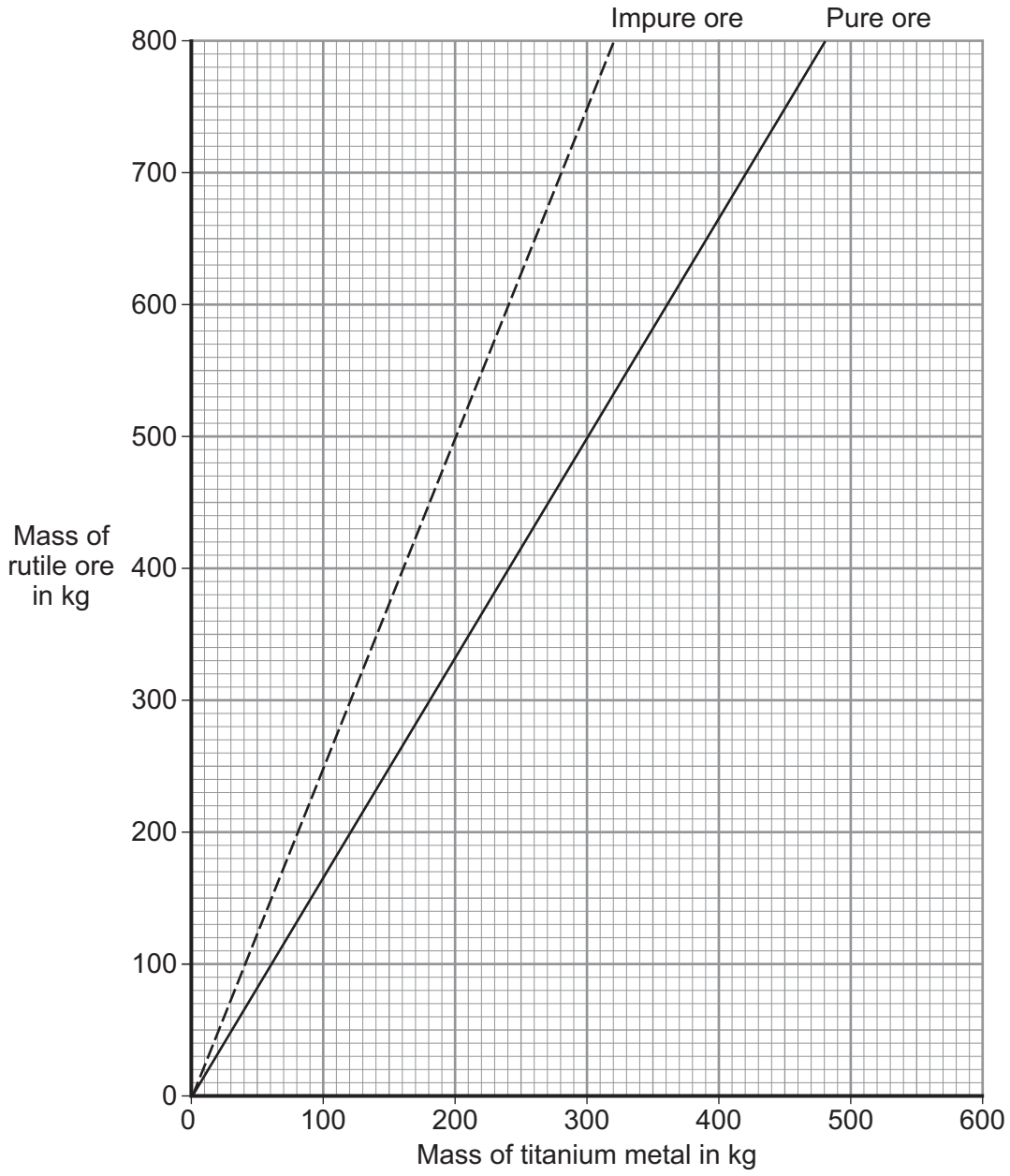
Calculate the mass of titanium metal produced.

.....

Mass = ... kg

(1 mark)

2 (f) The graph shows the mass of titanium metal produced from a pure rutile ore and from an impure rutile ore.



The difference between the two lines represents the amount of waste rock in the impure ore.

300 kg of titanium metal was produced from the impure ore.

Calculate the mass of waste rock in the impure ore.

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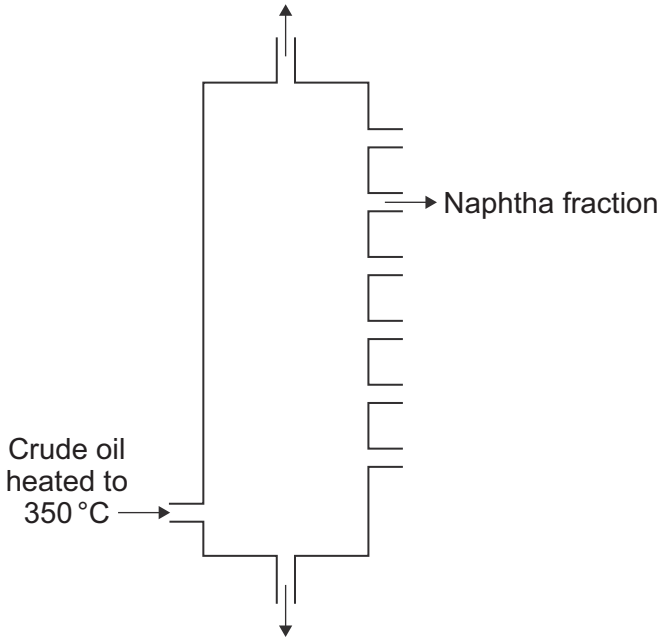
Mass = ... kg

(1 mark)

8

3 Crude oil is used to produce poly(ethene).

3 (a) Fractional distillation is used to separate crude oil into fractions.



3 (a) (i) Write a number, **2**, **3**, **4** or **5**, next to each stage so that the description of fractional distillation is in the correct order. Numbers **1** and **6** have been done for you.

Number	Stage
1	The crude oil is heated to 350 °C.
	When a fraction in the vapours cools to its boiling point, the fraction condenses.
	Any liquids flow down to the bottom of the column and the hot vapours rise up the column.
6	The condensed fraction is separated and flows out through a pipe.
	When the hot vapours rise up the column, the vapours cool.
	Most of the compounds in the crude oil evaporate.

(2 marks)

3 (a) (ii) The naphtha fraction is cracked to produce ethene (C_2H_4).
Ethene is used to make the polymer called poly(ethene).

Name **two** substances produced when poly(ethene) burns in air.

1 .....

2 .....

(2 marks)

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

Each year in the UK, billions of plastic bags are given free to shoppers. These bags are made from poly(ethene) and are often used only once.
After being used many of these plastic bags are either thrown away as litter or buried in landfill sites.

In 2006 over 10 billion of these plastic bags were given free to shoppers.
In 2009 the number of plastic bags given to shoppers had decreased to 6.1 billion.
One reason for the decrease was because some supermarkets made people pay for their plastic bags.

From 2011 a new type of plastic shopping bag made mainly from poly(ethene) had a use-by date of only one year printed on the bag.

Use the information above and your knowledge and understanding to describe advantages and disadvantages of using plastic shopping bags made from poly(ethene).

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(6 marks)

10

4 Venus is often compared to the Earth. The Earth's early atmosphere was mainly carbon dioxide like the atmosphere of Venus today.

Atmosphere of Earth today		Atmosphere of Venus today	
Gas	**Percentage (%)**	**Gas**	**Percentage (%)**
Nitrogen	78	Nitrogen	3.5
Oxygen	21	Oxygen	A trace
Carbon dioxide	0.04	Carbon dioxide	96

4 (a) Give **two** reasons why the percentage of carbon dioxide decreased in the Earth's early atmosphere.

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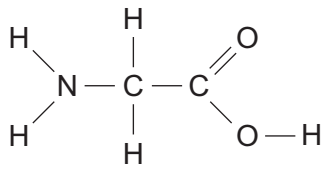
(2 marks)

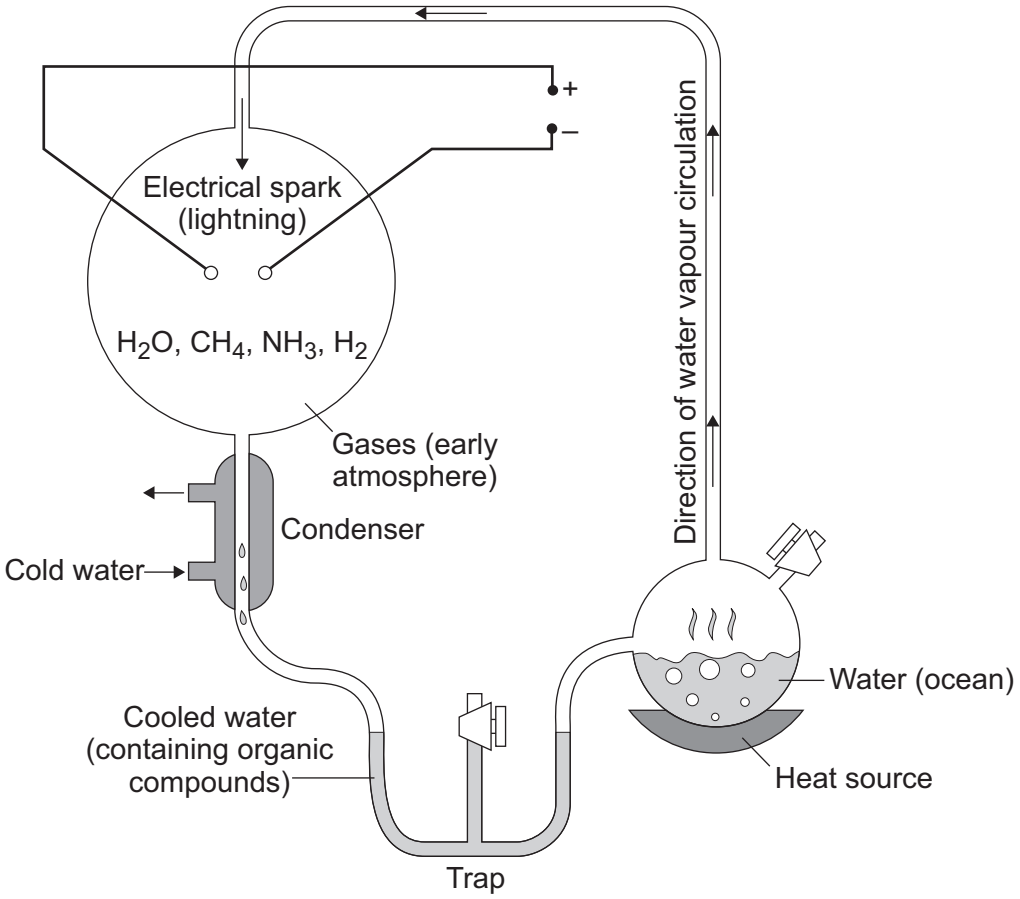
4 (b) In the 1950s two scientists, Miller and Urey, investigated the origin of life on Earth.
Miller and Urey used the gases that they believed were in the Earth's early atmosphere and used water to represent the oceans.
The gases they used were methane (CH_4), ammonia (NH_3) and hydrogen (H_2).
A continuous electrical spark was used to simulate lightning storms.

After one week the Miller-Urey experiment had produced amino acids.
Amino acids are essential to life.

The simplest amino acid is glycine (aminoethanoic acid).



The apparatus used in the Miller-Urey experiment is shown in the diagram.



Use the information in the diagram and on page 10 to answer these questions.

4 (b) (i) Miller and Urey used methane, ammonia and hydrogen for the Earth's early atmosphere.

Suggest why.

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(1 mark)

4 (b) (ii) The experiment provides only weak evidence of how amino acids formed on Earth.

Suggest **two** reasons why.

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(2 marks)

5

5 Calcium carbonate is found in limestone.
Limestone is used as a building material.
Limestone is also used to make calcium oxide and calcium hydroxide.

5 (a) Limestone is heated to make calcium oxide.

5 (a) (i) Calcium oxide reacts with a substance to produce calcium hydroxide.
Name the substance.

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(1 mark)

5 (a) (ii) Calcium hydroxide reacts with a substance to produce calcium carbonate.
Name the substance.

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(1 mark)

5 (b) Limestone reacts with acids.

5 (b) (i) Balance the chemical equation for the reaction of calcium carbonate with hydrochloric acid.

$$CaCO_3 + HCl \longrightarrow CaCl_2 + CO_2 + H_2O$$

(1 mark)

5 (b) (ii) Buildings made from limestone are affected by the products from burning fossil fuels containing sulfur.

Explain why.

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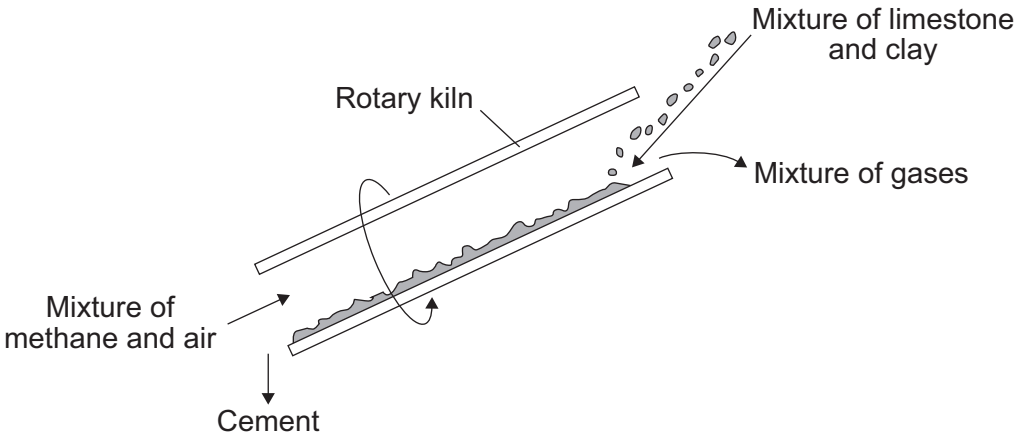
(2 marks)

5 (c) When a mixture of limestone and clay is heated in a rotary kiln cement is produced.
Burning a mixture of methane and air heats the kiln.
Clay does not decompose in the kiln.



5 (c) (i) Carbon dioxide is one of the main gases in the mixture of gases coming out of the kiln.

Give **two** reasons why.

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(2 marks)

5 (c) (ii) Name the other main gas in the mixture of gases coming out of the kiln.

Give a reason why there is a high percentage of this gas in the mixture of gases coming out of the kiln.

Name of gas .....

Reason .....

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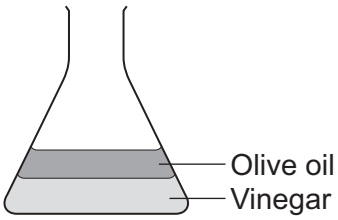
(2 marks)

9

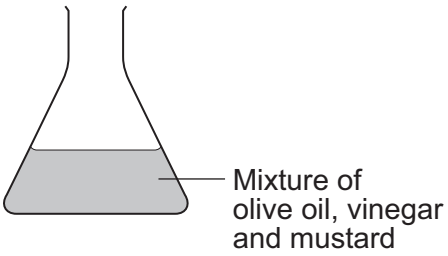
6 Olive oil is used to make salad dressings and margarine.

6 (a) Vinegar is often used to make salad dressings.
Vinegar contains 95% water and 5% ethanoic acid.

Simple salad dressing



French salad dressing



To make a simple salad dressing add olive oil to vinegar and shake. After a few minutes the mixture separates.
To make a French salad dressing add mustard to the olive oil and vinegar and shake. After several minutes the mixture does **not** separate.

6 (a) (i) Why does the mixture in the simple salad dressing separate?

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(1 mark)

6 (a) (ii) Mustard in the French salad dressing has molecules with hydrophilic properties and hydrophobic properties.

Explain why the French salad dressing does **not** separate.
You may include a diagram to help you to answer this question.

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(3 marks)

6 (b) Olive oil contains 89 % unsaturated fats and 11 % saturated fats.

What is the test and the result for unsaturated fats?

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(2 marks)

6 (c) Olive oil is hardened to make margarine.

Describe the reaction and conditions needed to harden a vegetable oil.

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(3 marks)

9

Turn over for the next question

7 Ethanol (C_2H_5OH) is produced from ethene or from sugar cane.

The two different methods to produce ethanol are summarised in the table.

Ethanol from sugar cane is a batch process	**Ethanol from crude oil is a continuous process**
Sugar cane plants are crushed and soaked in water for one day.	Crude oil is distilled to separate the naphtha fraction.
The sugar solution is separated by filtration.	The naphtha fraction is cracked when the vaporised hydrocarbons are passed over a hot catalyst.
Yeast is added to the sugar solution and fermented for three days.	The ethene produced is separated by distillation.
The solution of water and ethanol produced is separated by filtration.	Ethene is reacted with steam in the presence of a catalyst.
Distillation of this solution produces a 50 % solution of ethanol.	This hydration reaction produces 100 % ethanol.

7 (a) Complete and balance an equation for the cracking of the hydrocarbon C_6H_{14} to produce ethene.

C_6H_{14} ⟶ ..... + ...

(2 marks)

7 (b) What is **seen** when the sugar solution and yeast are fermented?

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(1 mark)

7 (c) Evaluate the issues involved with the production of ethanol from sugar cane compared with the production of ethanol from crude oil.
You should explain why each issue you describe is important.

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(5 marks)

8

Turn over for the next question

8 The table shows some properties of gases in dry air.

Gas in dry air	Density in kg/m^3	Melting point in °C	Boiling point in °C	Percentage (%) in air
Nitrogen	1.2506	–210	–196	78.08
Oxygen	1.4290	–219	–183	20.95
Carbon dioxide	1.977	–57	–57	0.033
Helium	0.1785	–272	–269	0.00052
Neon	0.8999	–249	–246	0.0019
Argon	1.7837	–189	–186	0.934
Krypton	3.74	–157	–153	0.00011
Xenon	5.86	–112	–108	0.0000087

8 (a) In 1895, Lord Rayleigh isolated nitrogen from dry air by removing the other known gases, oxygen and carbon dioxide.
He then discovered that nitrogen from dry air had a different density to pure nitrogen produced from chemical reactions.
He concluded that nitrogen extracted from dry air was mixed with another gas.
The density of nitrogen extracted from dry air was higher than the density of pure nitrogen.

Use the information above to explain why.

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(2 marks)

8 (b) Gases from the air are separated to provide raw materials used in many different industrial processes.

Steps in dry air separation:

Step 1: Filter to remove solid particles

Step 2: Remove carbon dioxide

Step 3: Cool the remaining air to –200 °C

Step 4: Separate by allowing the liquefied gases to warm up.

8 (b) (i) Carbon dioxide is removed before the air is cooled to –200 °C.

Suggest **one** reason why.

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(1 mark)

8 (b) (ii) Which two gases do **not** condense when the remaining air is cooled to –200 °C?

..... and .....

(1 mark)

8 (b) (iii) Two gases in air do **not** separate completely when the liquefied gases are allowed to warm up.

Name these **two** gases and give a reason for your answer.

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(2 marks)

6

END OF QUESTIONS