OCR
RECOGNISING ACHIEVEMENT

SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

GATEWAY SCIENCE

CHEMISTRY B

B742/02

Unit B742: Chemistry modules C4, C5, C6 (Higher Tier)

Candidates answer on the question paper
A calculator may be used for this paper

OCR Supplied Materials:
None

Other Materials Required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour 30 minutes

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Do not write outside the box bordering each page.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✎).
- The Periodic Table can be found on the back page.
- The number of marks for each question is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **85**.
- This document consists of **32** pages. Any blank pages are indicated.

Examiner's Use Only:			
1		10	
2		11	
3		12	
4		13	
5		14	
6		15	
7		16	
8		17	
9		18	
Total			

Answer **all** the questions.

Section A – Module C4

1 This question is about the elements in the Periodic Table.

Look at the list of elements.

argon	**calcium**
hydrogen	**iodine**
magnesium	**neon**
nitrogen	**oxygen**
potassium	**sodium**

Answer the questions.

Choose your answers from the list.

Each element can be used **once**, **more than once** or **not at all**.

The Periodic Table on the back page may help you.

(a) Write down the **name** of the non-metal element which is a **grey solid** at room temperature.

..... **[1]**

(b) Which element has an atom with only **five** electrons in its outer shell?

..... **[1]**

(c) Write down the **name** of the element which has the electronic structure 2.8.8.2.

..... **[1]**

[Total: 3]

2 Many scientists helped to develop the theory of atomic structure in the early 1900s.

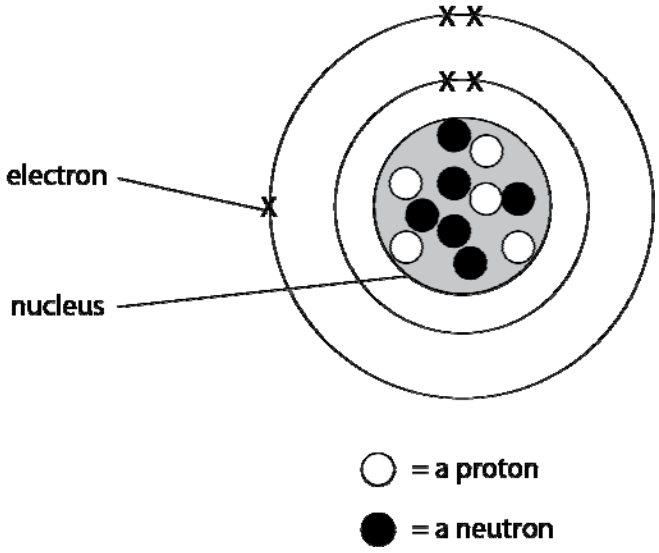
A scientist called Thomson discovered the electron.

Another scientist called Rutherford had the idea of atoms having a nucleus.

A third scientist called Bohr had the idea of electron shells.

Look at the diagram.

It shows the structure of an atom with a nucleus, electrons and electron shells.



(a) Explain why the nucleus of an atom has a positive charge.

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..... **[1]**

(b) The scientists Thomson, Rutherford and Bohr told other scientists about their ideas about atoms.

Suggest how and explain why they told other scientists.

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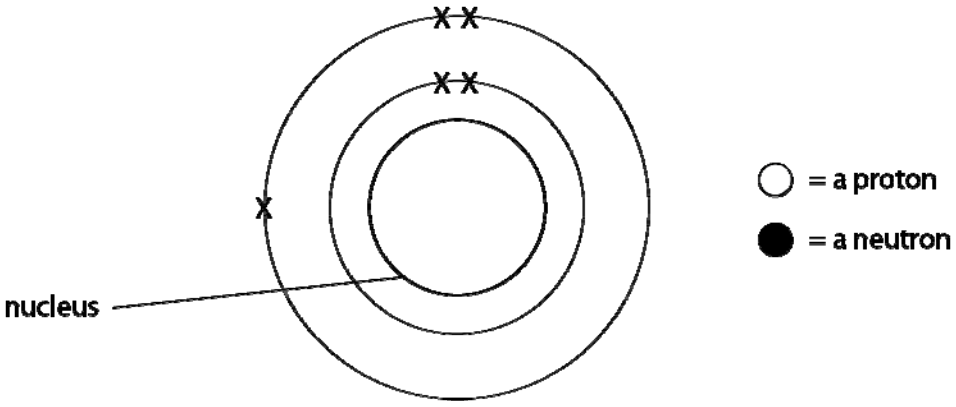
..... **[2]**

(c) Finish the diagram to show an isotope of the element above.



[1]

[Total: 4]

3 This question is about Group 1 elements such as sodium and rubidium.

Look at the table. It shows some information about the elements in Group 1.

element	atomic symbol	atomic number	melting point in ^{o}C	density in g/cm^3	atomic radius in pm
lithium	Li	3	181	0.53	152
sodium	Na	11	98	0.97	182
potassium	K	19	64	0.86	227
rubidium	Rb	37			

(a) Group 1 elements, such as sodium, react with water.

Sodium hydroxide, NaOH, and hydrogen are made.

Write down the **balanced symbol** equation for the reaction between sodium and water.

..... **[2]**

(b) The reaction of rubidium with water is more violent than the reaction of sodium with water.

Rubidium is more reactive than sodium.

Explain why.

Use ideas about electrons.

.....

.....

..... **[2]**

(c) Describe and explain the relationship between atomic radii and melting points of the elements in Group 1. Include in your answer predictions for the atomic radius and melting point of rubidium.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

[Total: 10]

4 This question is about the reaction of halogens with alkali metals.

(a) Astatine reacts with potassium.

Construct the **word** equation for this reaction.

..... **[1]**

(b) Chlorine reacts with sodium to make sodium chloride.

The electronic structure for chlorine is 2.8.7.

Use the 'dot and cross model' to describe the bonding in sodium chloride and in a molecule of chlorine.

You only need to include the outer shell electrons.

(i) sodium chloride

[2]

(ii) chlorine

[1]

[Total: 4]

5 River water needs to be purified before it can be used as drinking water.

Look at the table. It shows the mass of different ions in 1000 g of river water.

ion	mass in g
Ca^{2+}	0.00201
Br^{-}	0.00197
Cl	0.00180
K^{+}	0.00291
NO_3^{-}	0.00159
Pb^{2+}	0.00522
SO_4^{2-}	0.00481

(a) Kritica, a research chemist in a water purification factory, needs to know the percentage of lead ions in the water sample.

(i) What is the percentage by mass of lead ions, Pb^{2+}, in the river water?

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percentage =..... % **[1]**

(ii) The river water is treated in the water purification factory.

Suggest why the tap water the factory makes may still contain lead ions.

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..... **[1]**

(b) Kritica tests a sample of the polluted river water with barium chloride solution.

Predict what Kritica would observe and explain why.

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.....**[2]**

[Total: 4]

Section B – Module C5

6 Josh is worried about the amount of salt he eats.

Josh looks at this label on his packet of cornflakes.

It gives information about the amount of sodium and of salt in 100 g of cornflakes.

	mass in grams
sodium	0.7
salt	1.8

Josh wants to know if all the sodium in his cornflakes comes from salt.

Show by calculation that all of the sodium in cornflakes comes from salt, NaCl

The relative atomic mass of Na is 23 and of Cl is 35.5.

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..... **[2]**

[Total: 2]

7 Methanol, CH_3OH, can be made from carbon dioxide.

Look at the symbol equation for the reaction used to make methanol.

$$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g)$$

The reaction is exothermic.

The conditions used for this reaction are

- a temperature of 250 ^oC
- a pressure of 70 atmospheres
- a catalyst containing copper.

Explain, using ideas about rate of reaction and position of equilibrium, the choice of the three conditions used in this reaction.

✎ *The quality of written communication will be assessed in your answer to this question.*

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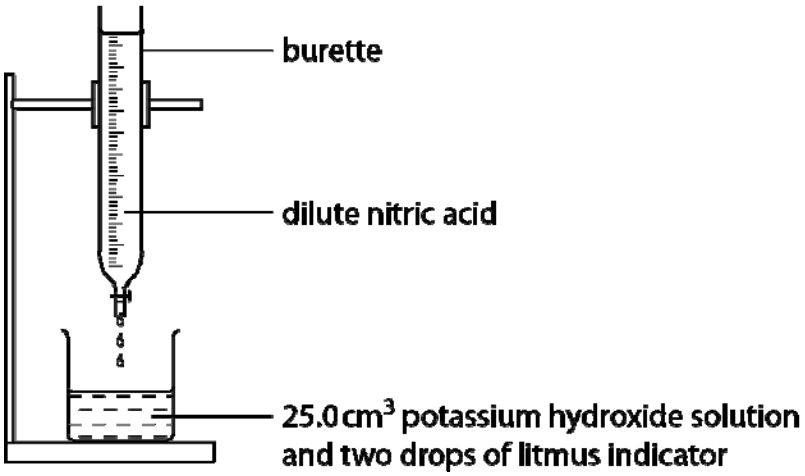
.....**[6]**

[Total: 6]

8 This question is about acid-base titrations.

Issy wants to find out the concentration of a sample of dilute nitric acid.

Look at the apparatus she uses.



She adds dilute nitric acid slowly until the litmus suddenly changes colour.

She repeats the experiment two more times.

Look at Issy's results table.

titration number	**1**	**2**	**3**
final burette reading in cm^3	29.7	27.0	34.8
initial burette reading in cm^3	8.5	6.9	24.9
volume of acid used (titre) in cm^3	21.2	20.1	19.9

(a) Issy does two experiments (**1** and **2**) and looks at her results.

She decides that she needs to do a third experiment (**3**).

Explain why she needs to do **three** experiments.

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..... **[2]**

(b) Litmus is a single indicator but universal is a mixed indicator.

In the titration experiment litmus suddenly changes colour from blue to red at the end-point.

If Issy uses universal indicator instead of litmus how would the colour change be different?

..... **[1]**

(c) Look at the balanced symbol equation for the reaction between potassium hydroxide and nitric acid.

$$KOH + HNO_3 \rightarrow KNO_3 + H_2O$$

Issy uses 25.0 cm^3 of potassium hydroxide solution.

The concentration of the potassium hydroxide is 0.100 mol/dm^3.

Use the mean titre to calculate the concentration, in mol/dm^3, of the nitric acid.

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

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concentration of nitric acid =..... mol/dm^3 **[4]**

[Total: 7]

9 Silicon dioxide and iron(**III**) hydroxide have been discovered on the planet Mars.

(a) Silicon dioxide, SiO_2, has a molar mass of 60 g/mol.

Calculate the molar mass of iron(**III**) hydroxide, $Fe(OH)_3$.

The relative atomic mass of H is 1, of O is 16, of Si is 28 and of Fe is 56.

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molar mass = ...g/mol **[1]**

(b) Compound **X** has been discovered on the planet Mars.

Compound **X** has the empirical formula CH.

Which **two** formulas could be the formula of compound **X**?

CH_4	**C_2H_2**
C_2H_6	**C_4H_8**
C_6H_6	**$C_{10}H_{22}$**

answer ..... and ..... **[1]**

[Total: 2]

10 Sulfamic acid solution is used to remove limescale in kettles.

Limescale is mostly calcium carbonate.

Sulfamic acid reacts with calcium carbonate as shown in the equation.

sulfamic acid + calcium carbonate → calcium sulfamate + carbon dioxide + water

Hayley investigates the reaction between sulfamic acid and calcium carbonate.

She adds 0.20 g of calcium carbonate powder to 100 cm^3 of sulfamic acid solution.

Hayley measures the total volume of carbon dioxide formed every minute.

Look at the table of her results.

time in minutes	**total volume of carbon dioxide in cm^3**
0	0
1	24
2	38
3	44
4	47
5	48
6	48
7	48

(a) Draw a labelled diagram to show the apparatus Hayley uses to collect these results.

[2]

(b) What is the amount, in moles, of carbon dioxide made at the end of the experiment?

One mole of any gas occupies 24 dm^3 at room temperature and pressure.

.....

.....

amount =..... mol **[1]**

(c) Hayley repeats the experiment with 100 cm^3 of hydrochloric acid.

She uses the same concentration of hydrochloric acid as sulfamic acid.

She finds the rate of reaction is much higher because hydrochloric acid is a strong acid and sulfamic acid is a weak acid.

Why does a strong acid react faster than a weak acid?

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..... **[2]**

[Total: 5]

11 Emma wants to prepare a pure dry sample of lead iodide by a precipitation reaction.

$$2KI(aq) + Pb(NO_3)_2(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$$

She starts with potassium iodide solution and lead nitrate solution.

Describe the steps Emma must do to get a **pure dry** sample of lead iodide.

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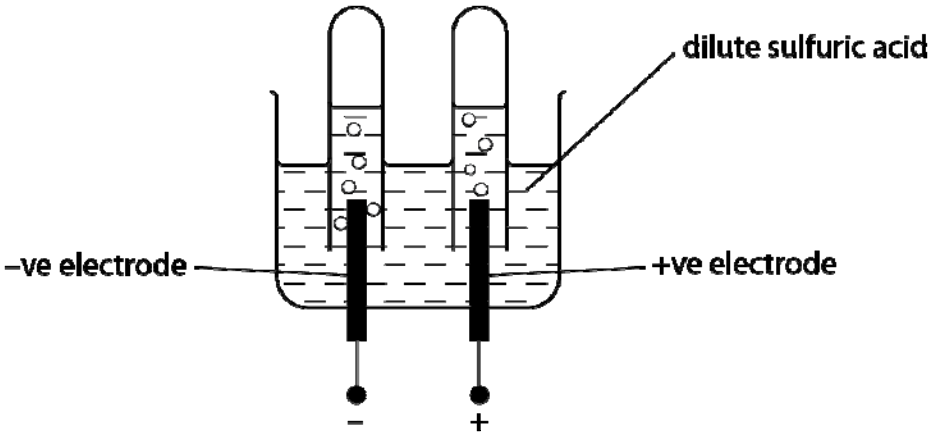
..... **[3]**

[Total: 3]

Section C – Module C6

12 Harry investigates the electrolysis of dilute sulfuric acid.

Look at the apparatus he uses.



(a) Bubbles of gas are made at both electrodes.

Hydrogen is one of the gases made.

Write down the name of the **other** gas made during the electrolysis.

..... **[1]**

(b) Hydrogen is made when hydrogen ions, H^+, gain electrons.

Construct the **balanced symbol equation** for this process.

Use e^- to represent an electron.

..... **[1]**

(c) Harry measures the time it takes to fill the test tube with hydrogen.

He does four experiments.

He changes the current used and the temperature of the dilute sulfuric acid.

He keeps everything else the same.

Look at his table of results.

experiment number	temperature of dilute sulfuric acid in ^{o}C	current used in amps	time taken to fill the test tube with hydrogen in seconds
1	10	1.0	60
2	15	1.0	60
3	15	2.0	30
4	15	4.0	15

Harry does another experiment.

This time he uses dilute sulfuric acid at a temperature of 20^{o}C and a current of 3.0 amps.

Predict how long it will take to fill the test tube with hydrogen.

Explain your answer.

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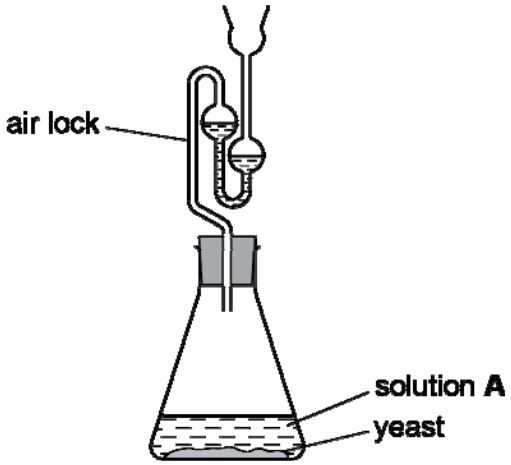
time = ...seconds **[2]**

[Total: 4]

13 Sarah and Daniel investigate fermentation.

Look at the diagram.

It shows the apparatus they use.



(a) Ethanol is made by fermentation.

Yeast and solution **A** are used to make ethanol.

Write the **word** equation for fermentation.

..... **[1]**

(b) Fermentation works best at temperatures between 25 – 50°C.

Explain why.

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..... **[2]**

(c) Write down the **molecular formula** of ethanol.

..... **[1]**

[Total: 4]

14 Look at the picture of a car.

(a) Some of the car body is made of iron.

One disadvantage of using iron is that it rusts.

Write a **word** equation for the rusting of iron.

..... **[1]**

(b) Look at the equations.

These are two processes that happen during rusting.

$$Fe - 2e^- \rightarrow Fe^{2+}$$

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH$$

Rusting is a redox reaction.

Explain why using information from **both** equations.

.....

..... **[1]**

(c) Look at the table. It shows different methods of rust prevention.

method of prevention	can be chipped or scratched?	provides sacrificial protection?	cost
painting	yes	no	low
tin plating	yes	no	high
galvanising	yes	yes	high

A car manufacturer decides that galvanising is the best method to prevent rust.

What evidence supports this?

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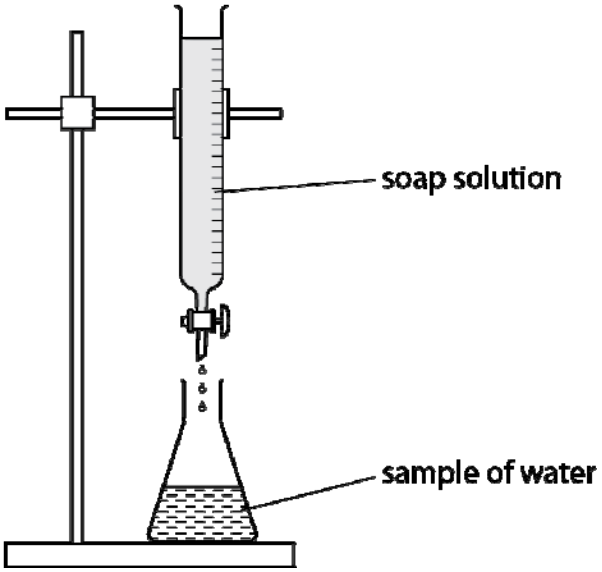
.....

..... **[1]**

[Total: 3]

15 This question is about hardness in water.

Luke and Henry investigate the hardness of three different samples of water.



They do this by adding drops of soap solution to each 50 cm^3 sample of water.

They add soap until lather remains on the surface after shaking.

Look at their table of results.

sample of water	volume of soap added in cm^3
tap water	30
river water	28
boiled tap water	15
distilled water	5

Tap water contains **both** temporary hardness and permanent hardness.

Explain how you can tell from the results.

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..... **[2]**

[Total: 2]

16 In 1950 research scientists thought that CFCs were very useful compounds.

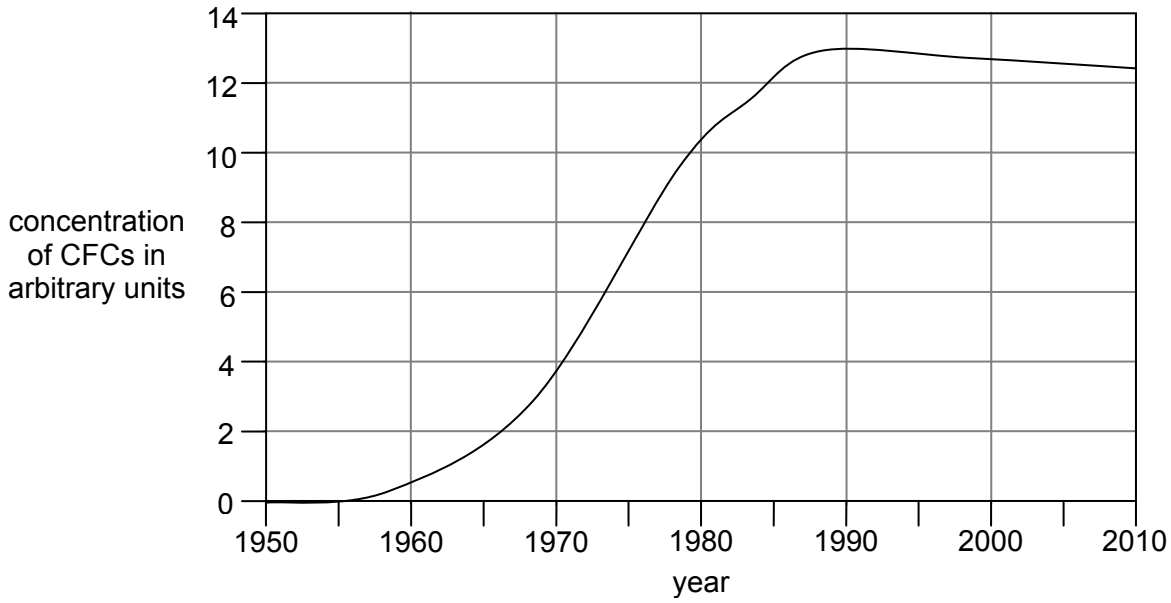
Many CFCs were used as aerosol propellants.

By 1980 some scientists believed that CFCs in the air were causing environmental damage.

CFCs enter the air when aerosol cans are used or thrown away.

(a) Look at the graph.

It shows how the concentration of CFCs in the air has changed since 1950.



The UK government has now banned the use of CFCs.

(i) Use the graph to estimate in which year the ban on the use of CFCs started.

..... **[1]**

(ii) It took a long time for scientists to convince the UK government to ban CFCs.

Suggest why.

.....

..... **[1]**

(iii) Research scientists have estimated that the mean decrease in concentration of CFCs will be about 1.35 arbitrary units every ten years.

Estimate when the concentration of CFCs in the air falls to zero.

.....

.....

year = ...**[2]**

(b) Ozone molecules in the upper atmosphere break down when they absorb ultra violet light to make oxygen atoms and oxygen molecules.

(i) Construct the **balanced symbol** equation for this reaction.

..... **[1]**

(ii) The breakdown of CFCs only occurs in the upper atmosphere and not at ground level.

Suggest why.

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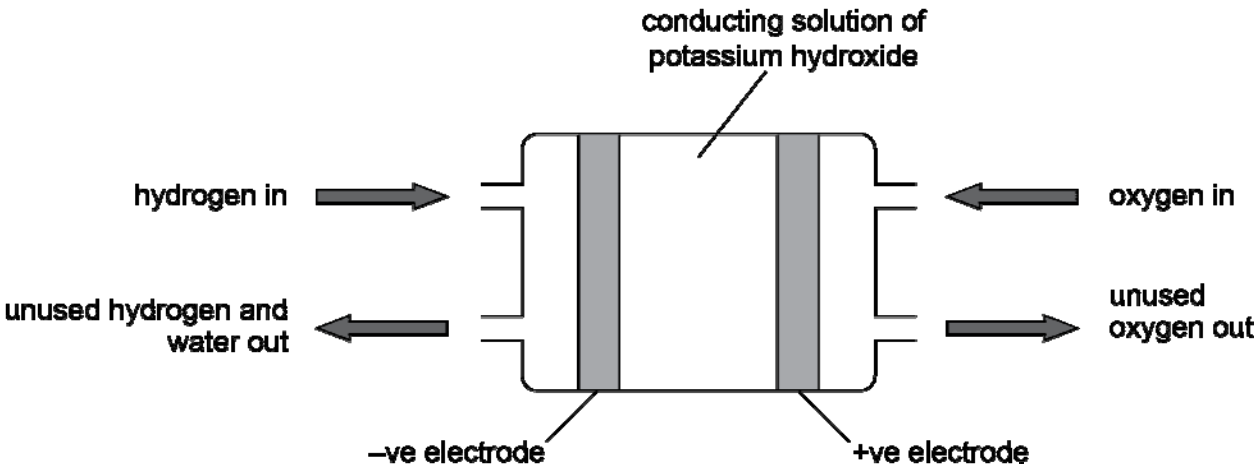
..... **[1]**

[Total: 6]

17 Look at the diagram of an oxygen-hydrogen fuel cell



Potassium hydroxide solution contains potassium ions, K^+, and hydroxide ions, OH^-. Water, H_2O, is made in this type of fuel cell.

Construct the electrode equations for the reactions that take place in this oxygen-hydrogen fuel cell.

Use these equations and your own understanding to explain the advantages and disadvantages of producing electricity using an oxygen-hydrogen fuel cell.

✎ *The quality of written communication will be assessed in your answer to this question.*

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..... **[6]**

[Total: 6]

Section D

18 Look at the information about bio-fuels.

Bio-fuels

- are renewable fuels used in motor vehicles
- are made from plant materials
- burn in air to release useful energy in the form of heat
- burn in air to make carbon dioxide and water.

Farmers have to use valuable land to grow crops for bio-fuels.

They cannot use the same land to grow food crops.

Some people call bio-fuels carbon-neutral.

This is because plants use carbon dioxide to photosynthesise.

(a) Look at Table 1.

It gives some information about the production of bio-fuels in 2007.

Table 1

bio-fuel	units of energy used during growth and manufacture	total energy content of bio-fuel produced in units of energy
bio-ethanol	378	924
bio-diesel	1	64

Energy is used during the growth and manufacture of bio-fuels.

This has to be set against the total energy content of the fuel.

Suggest, with a reason, one advantage of producing bio-diesel rather than bio-ethanol.

.....

..... **[1]**

(b) Bio-diesel can be produced from a wide range of different plants.

Look at Table 2.

It shows the average volume of bio-diesel you can get from different plants.

Table 2

plant used to make bio-diesel	average volume of bio-diesel in dm^3 from a 1000 m^2 area
coconut	35
corn	7
hemp	150
palm	115
peanut	15
rape	16
soy	12
sunflower	13

Elizabeth is a farmer.

She has a field with an area of 10 000 m^2.

She wants to produce as much bio-diesel as possible from her field.

Which plant should she grow and how much bio-diesel would she produce?

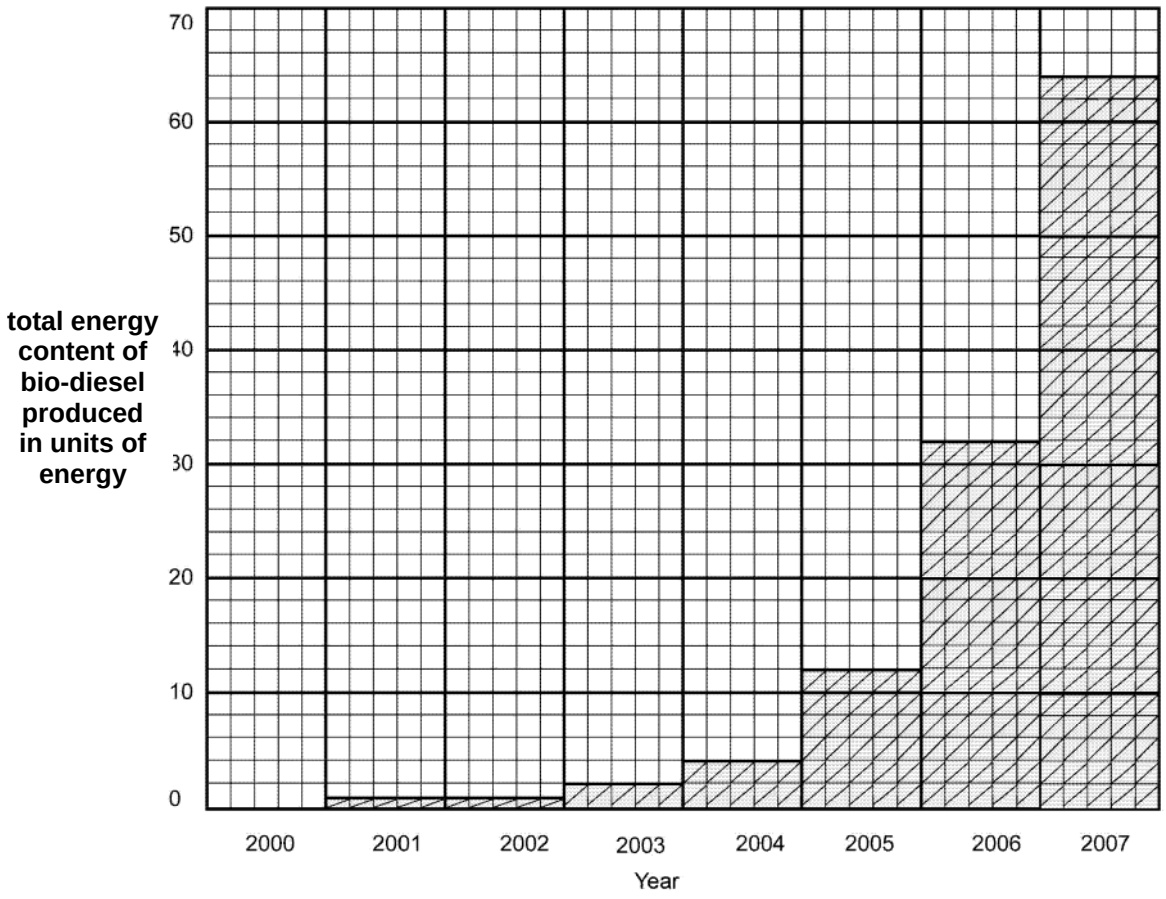
.....

.....

..... **[1]**

(c) Look at the bar chart.

It shows the total energy content of the bio-diesel produced each year since the year 2000.



(i) The amount of bio-diesel produced is likely to continue to increase.

Suggest **two** reasons why it is difficult to predict the total energy content of bio-diesel produced in 2011.

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..... **[2]**

(ii) What are the possible consequences of this increase in bio-diesel production?

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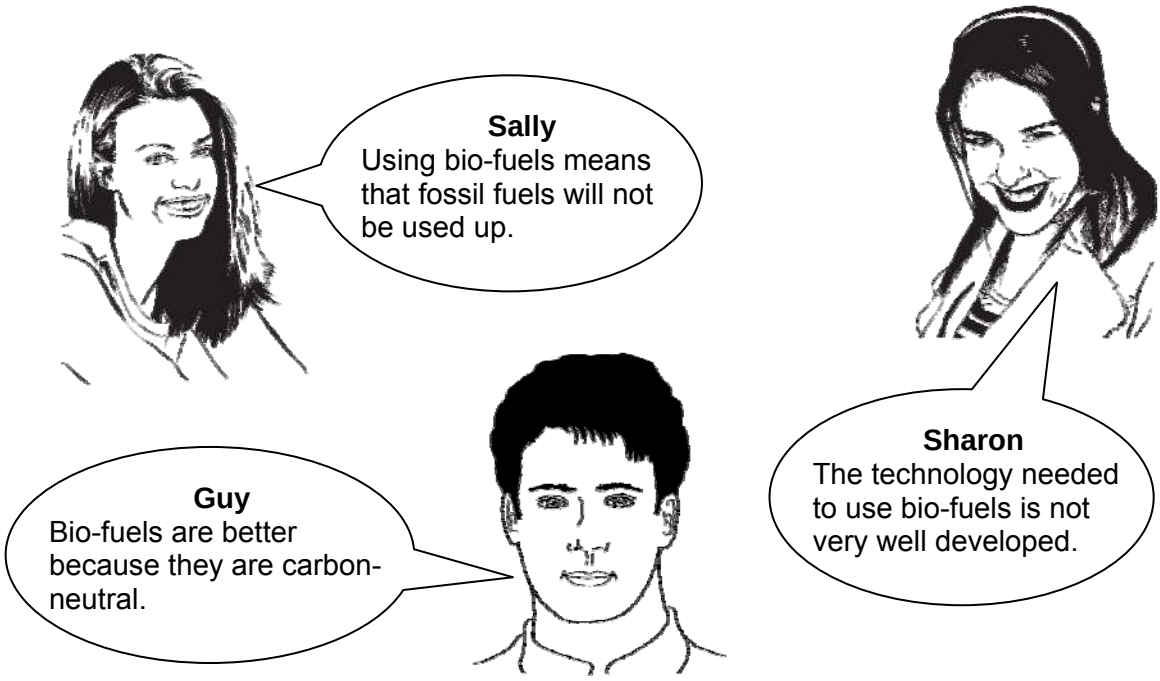
..... **[1]**

(d) Three friends are discussing using bio-fuels.



Use all the evidence in this section to discuss the reasons for and against growing crops for bio-fuels.

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..... **[5]**

[Total: 10]

[Paper Total: 85]

END OF QUESTION PAPER

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PERIODIC TABLE

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **A**l aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **C**l chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **T**l thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.