OCR
Oxford Cambridge and RSA

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Monday 20 June 2016 – Morning

GCSE GATEWAY SCIENCE
CHEMISTRY B

B742/02 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

* B 7 4 2 0 2 *

* 4 3 9 8 5 8 8 1 3 9 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The 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 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.

Answer **all** the questions.

SECTION A – Module C4

1 Look at the table. It shows some information about four atoms.

Atom	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electronic structure
W	17	37	17	20	17	2.8.7
X	17	35	17	18	17	2.8.7
Y	3	7	.....	.....	3	2.1
Z	6	.....	6	6	6	.....

(a) Complete the table. **[3]**

(b) Atom **W** and atom **X** are both chlorine atoms.

What is the name given to chlorine atoms such as **W** and **X**?

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Explain your answer.

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

[Total: 5]

2 At very low temperatures some metals can be **superconductors**.

This means that they can conduct electricity with little or no resistance.

(a) Write about **two** potential benefits of superconductors.

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

(b) Explain **one** drawback of using superconductors.

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

[Total: 3]

3 Look at the table.

It shows information about the Group 7 elements.

Element	Appearance	Melting point in °C	Boiling point in °C	Order of reactivity
fluorine	yellow gas	–220	.....	most reactive
chlorine	green gas	–101	–34	↕
bromine	red/brown liquid	–7	59	
iodine	.....	114	184	
astatine	black solid	.....	337	least reactive

(a) Complete the table. Use ideas about trends down a group. **[3]**

(b) Fluorine is more reactive than astatine.

Explain the trend in the reactivity of the Group 7 elements.

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

[Total: 5]

4 Jed is testing iron(III) chloride and some unknown compounds.

He does some tests.

These are the tests that Jed does on solutions of the compounds:

- adding sodium hydroxide solution
- adding silver nitrate solution.

Look at his results.

Compound	Adding sodium hydroxide solution	Adding silver nitrate solution
iron(III) chloride	brown solid made	white solid made
A	blue solid made	white solid made
B	green solid made	cream solid made

Iron(III) chloride, $FeCl_3$, reacts with silver nitrate, $AgNO_3$, to make silver chloride, $AgCl$, and iron(III) nitrate, $Fe(NO_3)_3$.

Write a **balanced symbol** equation for this reaction.

Identify the unknown compounds **A** and **B** and explain your answers.

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

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

[Total: 6]

5 Fluorine reacts with chlorine to make a compound called chlorine fluoride, C*l*F.

C*l*F is a **covalent** compound.

The electronic structure of chlorine is 2.8.7.

The electronic structure of fluorine is 2.7.

(a) Draw a 'dot and cross' diagram to show the covalent bonding in chlorine fluoride.

[2]

(b) Chlorine fluoride has a **simple molecular** structure.

Predict **two** physical properties of chlorine fluoride.

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

(c) Chlorine and fluorine are in Group 7 of the Periodic Table.

One scientist who helped to develop the Periodic Table was called Mendeleev.

Write about how Mendeleev helped in the development of the Periodic Table.

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

[Total: 6]

SECTION B – Module C5

6 Kate and Steve are testing some water samples.

They use lead nitrate solution and barium chloride solution.

They add each solution to different samples of water.

Look at the table. It shows their results.

Water sample	Effect of adding lead nitrate solution	Effect of adding barium chloride solution
A	white precipitate	no reaction
B	yellow precipitate	white precipitate
C	no reaction	white precipitate

Which negative ions are in each water sample?

Explain your answers.

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

[Total: 3]

7 Hydrochloric acid is a **strong** acid.

Ethanoic acid is a **weak** acid.

Both acids can either be concentrated or dilute.

(a) Explain the difference between acid **strength** and acid **concentration**.

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

(b) Nick and Lesley add 25 cm^3 of hydrochloric acid to 1 g of calcium carbonate.

They also add 25 cm^3 of ethanoic acid to 1 g of calcium carbonate.

Both acids have the **same concentration**.

Carbon dioxide is made in both reactions.

(i) The hydrochloric acid reacts faster with calcium carbonate than the ethanoic acid.

Use ideas about particles to explain why.

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

(ii) Both acids make the **same volume** of carbon dioxide.

Explain why.

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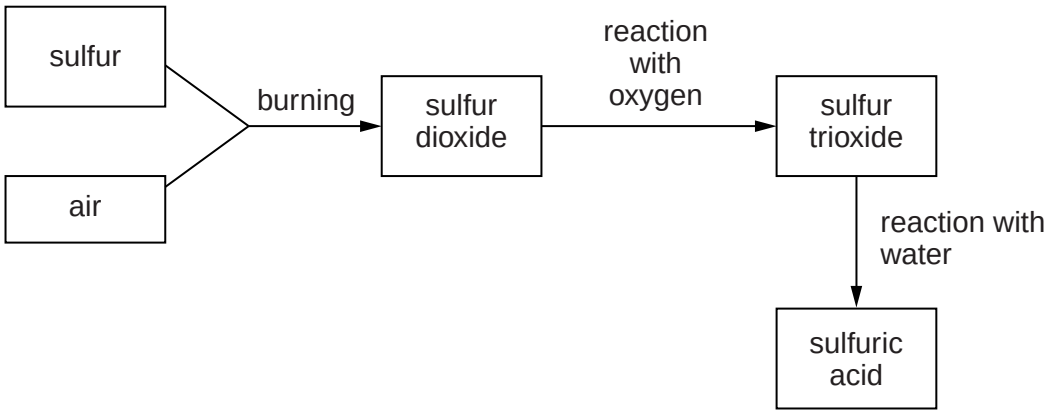
..... **[1]**

[Total: 4]

8 This question is about the Contact Process used for the manufacture of sulfuric acid.

Look at the flow chart for the process.



In the process, sulfur dioxide reacts with oxygen to make sulfur trioxide.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

The forward reaction is **exothermic**.

Two of the conditions used are:

- a temperature of 450 °C
- a low pressure of 3 atmospheres.

(a) Write down **one other** condition used in the process.

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

(b) Explain the choice of conditions used in the process.

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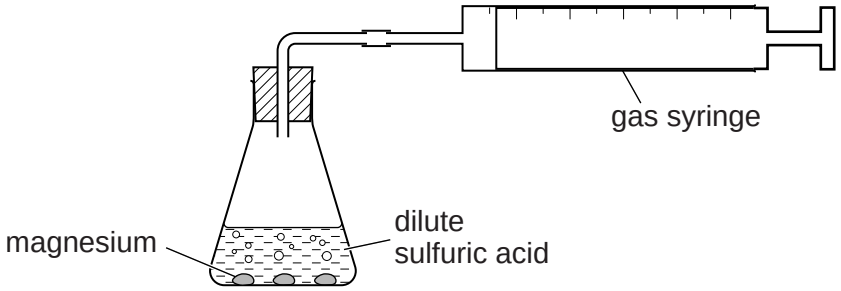
..... **[3]**

[Total: 4]

9 Hayley and Andy investigate the reaction between magnesium and sulfuric acid.

Look at the diagram. It shows the apparatus they use.

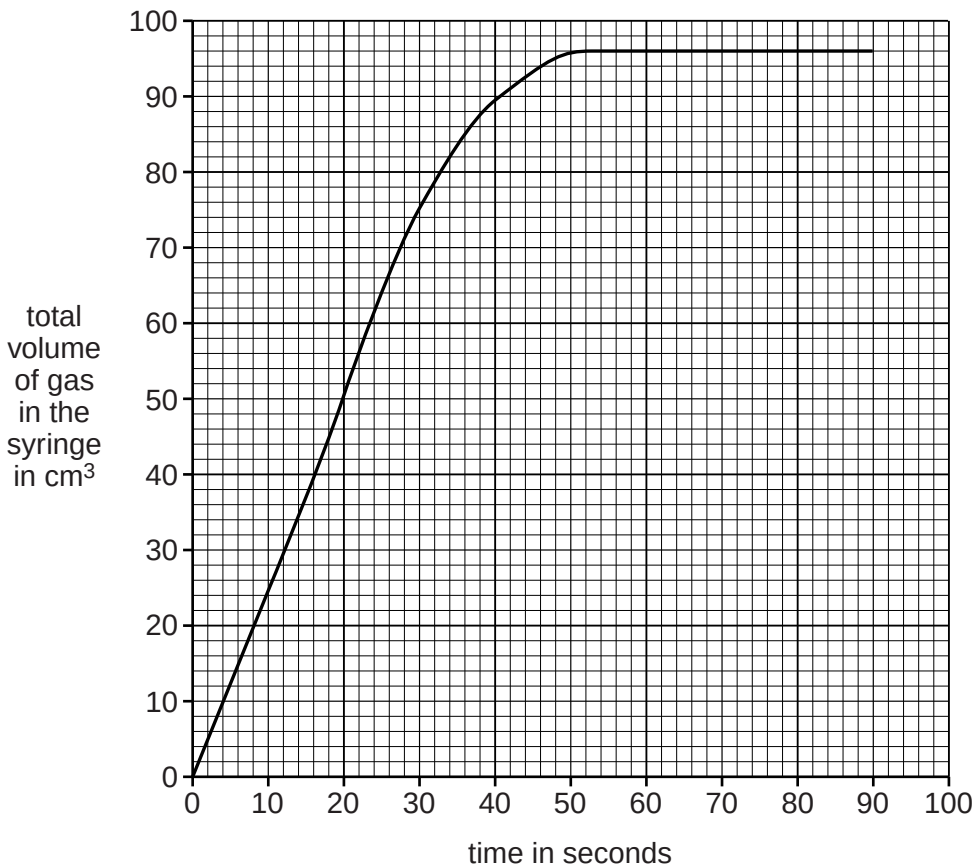


They add 0.1 g of magnesium to 50 cm^3 of sulfuric acid.

They measure the total volume of gas in the syringe every 10 seconds.

All the magnesium is used up at the end of the reaction.

Look at the graph of their results.



(a) (i) What is the total volume of gas in the syringe after 30 seconds?

answer ..... cm^3 **[1]**

(ii) How long does it take for the reaction to stop?

answer ..... seconds **[1]**

(iii) Hayley and Andy do the experiment again.

They use the same volume and concentration of sulfuric acid.

This time they only use 0.05 g of magnesium.

On the grid, sketch the graph they should get. **[2]**

(b) Look at the equation for the reaction.

magnesium + sulfuric acid → magnesium sulfate + hydrogen

Hayley and Andy investigate this reaction with different masses of magnesium.

They calculate the mass of sulfuric acid used and the masses of magnesium sulfate and hydrogen made.

Mass of magnesium in g	Mass of sulfuric acid in g	Mass of magnesium sulfate in g	Mass of hydrogen in g
0.50	2.04	2.50	0.04
1.00	4.08	5.00	0.08
1.50	6.12	7.50	0.12
2.00	8.16	10.00	0.16

(i) Calculate the mass of magnesium sulfate made if 10 g of magnesium completely reacts with sulfuric acid.

Explain how you worked out your answer.

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

(ii) A sample of 2.00 g of magnesium makes 0.16 g of hydrogen.

Calculate the number of moles in 0.16 g of hydrogen, H_2.

The relative atomic mass, A_r, of H = 1.

number of moles = ... **[1]**

(iii) Calculate the volume of 0.16 g of hydrogen at room temperature and pressure.

1 mole of hydrogen occupies 24 000 cm^3 at room temperature and pressure.

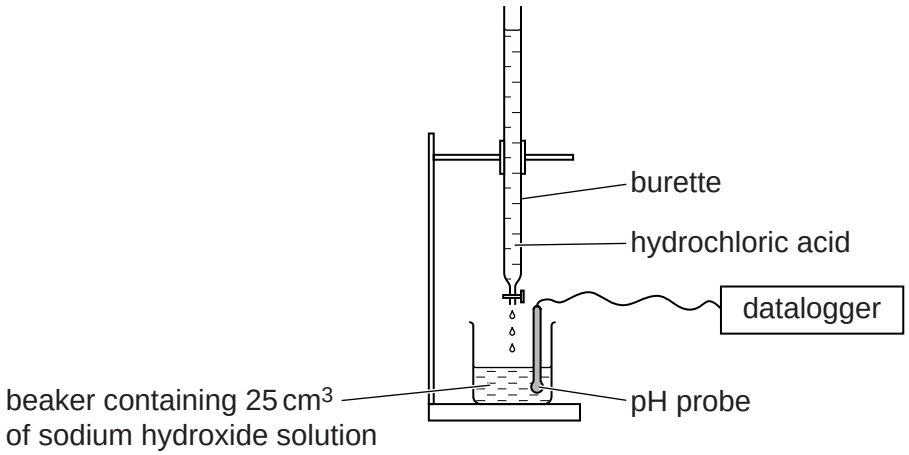
volume = ... cm^3 **[1]**

[Total: 8]

10 Stewart and Claire want to do a titration.

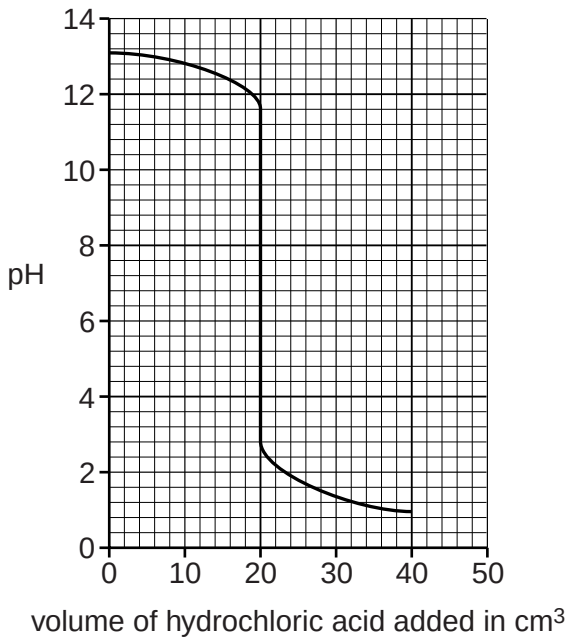
They use a solution of hydrochloric acid with a concentration of 0.10 mol/dm^3.

They titrate 25 cm^3 of a solution of sodium hydroxide with the hydrochloric acid.



They measure the pH of the mixture during the titration.

Look at the graph of their results.



The equation for the reaction is

$$NaOH + HCl \rightarrow NaCl + H_2O$$

What can you deduce from the graph? Include the volume of hydrochloric acid added at the end-point.

Use the graph to calculate the concentration of the sodium hydroxide solution.

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

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[Total: 6]

SECTION C – Module C6

11 Fats are made by the reaction between an alcohol called glycerol and carboxylic acids.

(a) What **type** of compound is a fat?

Choose from

alkene

emulsion

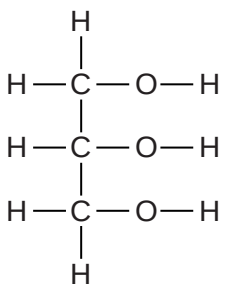
ester

soap

solvent

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

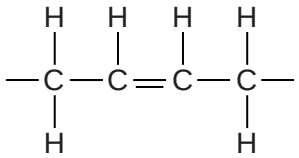
(b) Look at the displayed formula of a molecule of glycerol.



What is the **molecular formula** of glycerol?

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

(c) Look at part of the displayed formula of a fat.



The fat is **unsaturated**.

(i) How can you tell from its formula?

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

(ii) Dave does a chemical test to show that the fat is unsaturated.

Write about the chemical test and the result Dave gets.

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

(d) Vegetable oils are also fats.

Vegetable oils can be used to make margarine.

Write about how margarine is manufactured.

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

[Total: 7]

12 Colin investigates displacement reactions.

He adds some iron powder to copper(II) sulfate solution, $CuSO_4$.

A displacement reaction happens.

Look at the ionic equation for this reaction.

$$Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$$

This displacement reaction is a **redox** reaction.

Write the **word** equation and the **balanced symbol** equation for the reaction between iron and copper(II) sulfate.

Explain why this displacement reaction involves both oxidation and reduction.

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

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[Total: 6]

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Question 13 begins on page 18.

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13 The compound $C_2F_2Cl_4$ is a CFC.

CFCs have been linked with the depletion of the ozone layer.

Look at the equations for five reactions that occur in the stratosphere.

Reaction **1** $C_2F_2Cl_4 \rightarrow C_2F_2Cl_3 + Cl$

Reaction **2** $Cl + O_3 \rightarrow ClO + O_2$

Reaction **3** $ClO + O \rightarrow Cl + O_2$

Reaction **4** $O_3 \rightarrow O_2 + O$

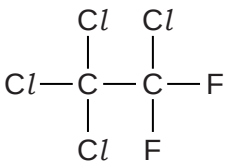
Reaction **5** $O + O_2 \rightarrow O_3$

(a) Ozone absorbs harmful ultraviolet radiation.

Which reaction happens when ozone absorbs ultraviolet radiation?

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

(b) Look at the displayed formula for $C_2F_2Cl_4$.



Explain, in terms of electrons and bonds, how the chlorine atoms are made in reaction **1**.

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

(c) One chlorine atom can destroy many ozone molecules.

Use reactions from the list to explain why.

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

(d) When CFCs were first discovered scientists thought they were extremely useful compounds.

Scientists' attitudes to CFCs have changed over the last 70 years.

The use of CFCs in the UK has now been banned.

It took a long time between the first use of CFCs and the ban by the UK government.

Suggest why.

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

[Total: 7]

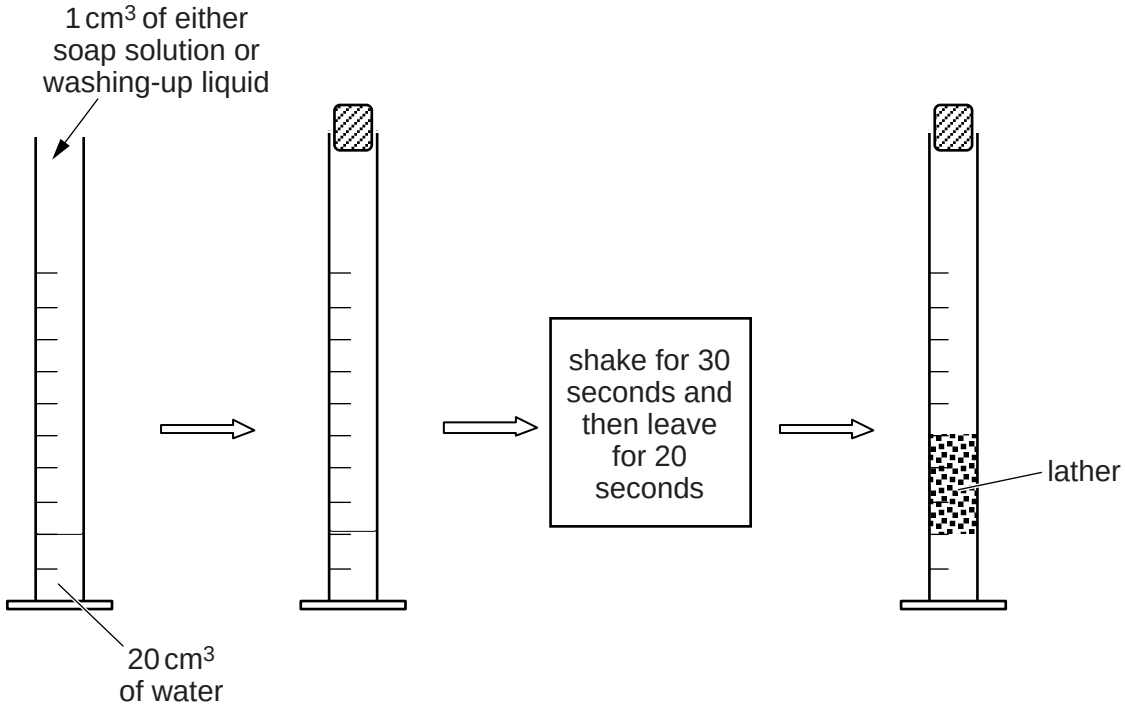
14 Magda and Sam investigate soap solution and washing-up liquid.

In their first experiment they measure out 20 cm^3 of a water sample in a measuring cylinder.

They then add 1 cm^3 of soap solution to the water sample.

Magda shakes the measuring cylinder for 30 seconds.

Sam waits 20 seconds and then measures the volume of lather in the measuring cylinder.



Magda and Sam repeat this experiment using different water samples and soap solution.

They then repeat the experiments using washing-up liquid instead of soap solution.

Look at Magda and Sam's results.

Water sample	Volume of lather with soap solution in cm^3	Volume of lather with washing-up liquid in cm^3
distilled water	30	60
magnesium sulfate solution	5	40
calcium hydrogencarbonate solution	10	60
sodium chloride solution	25	60

Before she did the experiment, Magda predicted that temporary water hardness affects the action of **both** soap **and** of washing-up liquid.

Is this prediction supported by the results?

Explain your answer quoting data from the results table.

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

[Total: 2]

15 Molten (liquid) potassium chloride can be electrolysed.

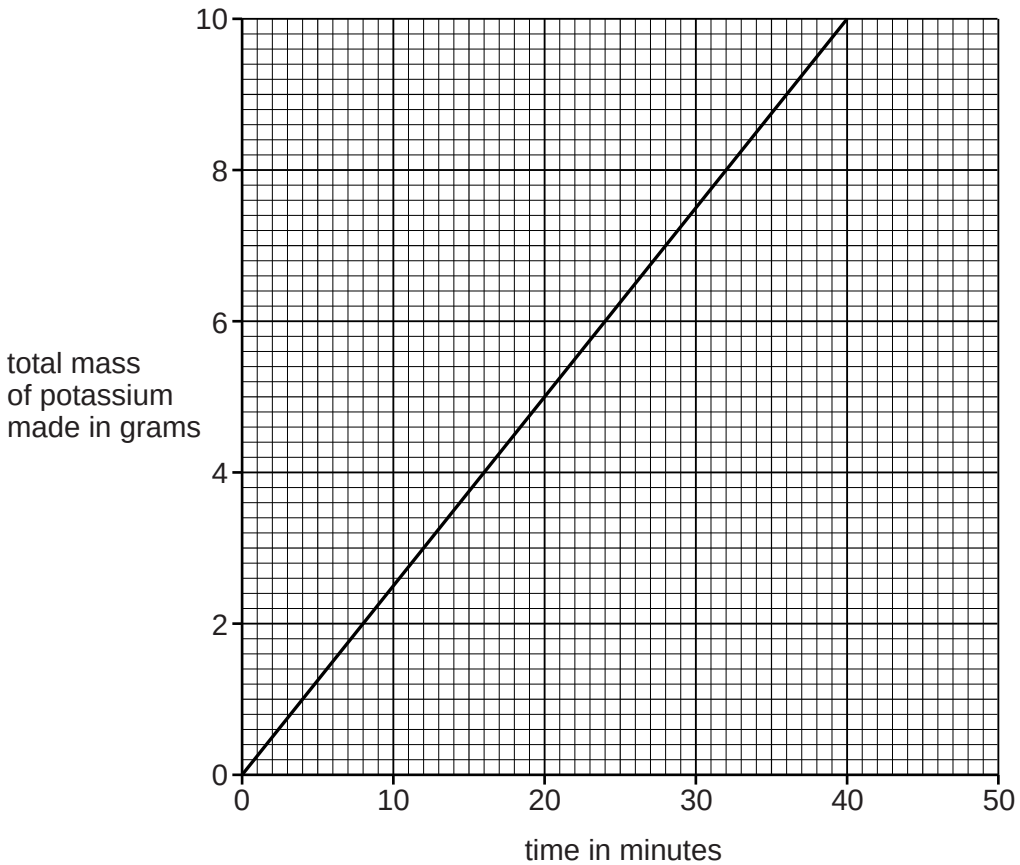
Potassium is made.

Manjit investigates the mass of potassium made when molten potassium chloride is electrolysed.

She always uses a current of 10.3 amps.

She does the electrolysis for different lengths of time.

Look at the graph of her results.



(a) What is the total mass of potassium made in 30 minutes?

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

(b) Manjit electrolyses molten potassium chloride for 120 minutes.

She uses a current of 20.6 rather than 10.3 amps.

Predict the mass of potassium made.

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

[Total: 3]

SECTION D

16 Farmers use fertilisers to improve crop yield.

Fertilisers contain one or more of the three essential elements.

These essential elements are nitrogen, phosphorus and potassium.

Fertilisers made in factories are called **synthetic** fertilisers.

(a) Look at **Graph 1**.

It shows the world use of synthetic fertilisers containing nitrogen between the years 1950 and 2010.

Vaclav Smil, Feeding the world, 2000 and Food and Agriculture Organization FAO.
Removed due to third party restrictions.

Graph 1

(i) What mass of fertilisers containing nitrogen was used in 1970?

mass = ... millions of tonnes **[1]**

(ii) Look at **Graph 2**.

It shows the concentration of nitrate ions, NO_3^-, from fertilisers in the River Rhine between the years 1950 and 2010.

Vaclav Smil, Feeding the world, 2000 and Food and Agriculture Organization FAO. Removed due to third party restrictions.

Graph 2

Pollution controls were introduced for the River Rhine in 1977 to reduce nitrate, NO_3^-, concentrations.

What evidence is there from **Graph 2** that these controls have been effective?

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

(b) Farmers also use **pesticides** to increase crop yield.

Pesticides kill pests such as insects which eat the crops.

Look at the table. It shows the use of synthetic fertilisers and pesticides in some countries.

Country	Mass of synthetic fertilisers used in 1 km^2 of agricultural land in kg	Mass of pesticides used in 1 km^2 of agricultural land in kg	Percentage of land area available for agriculture (%)
A	26 000	66	61
B	963 000	128 000	4
C	62 000	1400	34
D	67 000	740	34
E	330 000	1000	18

(i) The agricultural land area of country **E** is 1 260 000 km^2.

Calculate the mass of **pesticides** used in country **E**.

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mass of pesticides = ... kg **[1]**

(ii) Country **B** uses much more synthetic fertiliser and pesticides per km^2 than country **A**.

Suggest why. Use information from the table.

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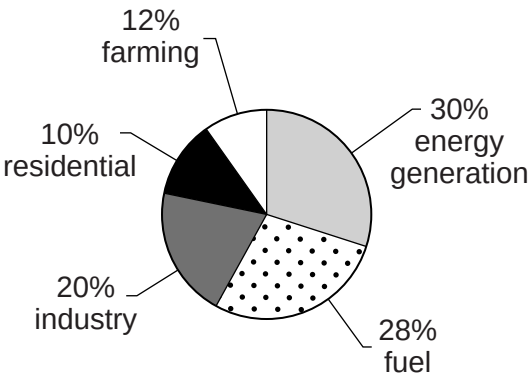
..... **[2]**

(c) The use of synthetic fertilisers also contributes towards the greenhouse effect.

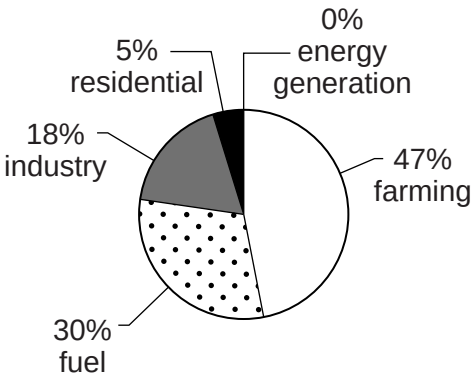
Look at the pie charts about three greenhouse gases.

They show where these greenhouse gases come from.

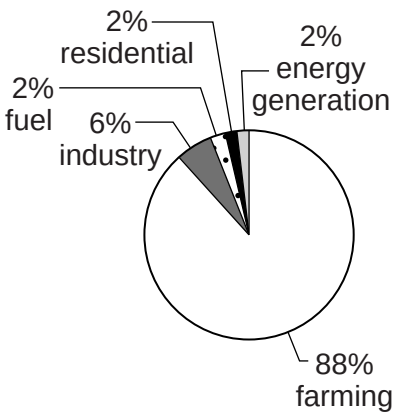
Carbon dioxide



Methane



Nitrous Oxide



(i) Suggest which gas is most likely to be made from the use of synthetic fertilisers.

Choose from carbon dioxide, methane or nitrous oxide.

How can you tell?

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

(ii) Farming has a bigger contribution towards the greenhouse effect than residential use.

Use the information in the pie charts to support this statement.

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

[Total: 10]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

The Periodic Table of the Elements

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 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** 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 **Tl** 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.*

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.