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Thursday 13 June 2013 – Morning

GCSE GATEWAY SCIENCE
CHEMISTRY B

B742/02 Chemistry modules C4 C5 C6 (Higher Tier)

B736990613

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

B742202

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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

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 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 **28** pages. Any blank pages are indicated.

Answer **all** the questions.

SECTION A – Module C4

1 Atoms contain electrons, neutrons and protons.

Look at the table. It shows the number of electrons, neutrons and protons in some atoms and ions.

Atom or ion	Number of		
	electrons	**neutrons**	**protons**
$^{1}_{1}H$	1	0	1
$^{2}_{1}H$	1	1	1
$^{31}_{15}P$	15	16	15
.....	15	17	15
$^{32}_{16}S^{2-}$	.....	16	16

(a) Complete the table. **[2]**

(b) $^{1}_{1}H$ and $^{2}_{1}H$ are **isotopes** of hydrogen.

What is meant by the term **isotope**?

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

(c) In 1808, a scientist named Dalton published his atomic theory.

About a century later, a scientist called Rutherford published another atomic theory.

Why is it important that scientists publish their theories?

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

[Total: 5]

2 **(a)** An element **X** has the electronic structure 2.8.8.2.

Explain how you can tell that element **X** is calcium.

.....

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

(b) Chlorine has the electronic structure 2.8.7.

Chlorine, Cl_2, is a covalent molecule.

Use the 'dot and cross' model to describe the bonding in a molecule of chlorine, Cl_2.

You only need to draw the outer shell electrons.

[2]

(c) Sodium chloride, NaCl, contains sodium ions, Na^+, and chloride ions, Cl^-.

Explain why sodium ions are positively charged and chloride ions are negatively charged.

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

(d) Chlorine reacts with sodium bromide solution.

Look at the **ionic** equation for this reaction.

$$Cl_2 + 2Br^- \longrightarrow Br_2 + 2Cl^-$$

Explain why chlorine is **reduced** in this reaction.

.....

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

(e) Chlorine also reacts with potassium iodide solution, KI.

Iodine and potassium chloride are made.

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

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

[Total: 8]

3 Lithium, Li, is in Group 1 of the Periodic Table.

Laura's teacher adds a small piece of lithium to a bowl of water.

The lithium reacts with the water, H_2O.

The lithium moves about on the surface of the water.

Laura sees bubbles of hydrogen, H_2, being made.

The piece of lithium gets smaller and smaller until it has completely reacted.

A solution of lithium hydroxide, LiOH, is made.

Caesium, Cs, is another element in Group 1.

Predict, including a balanced symbol equation, how the reaction of **caesium** with water compares with the reaction of **lithium** with water.

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

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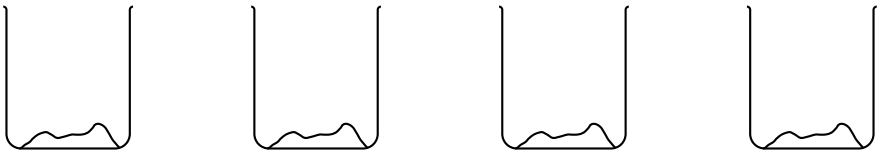
..... **[6]**

[Total: 6]

4 Oskar has four beakers containing different solids.



solid **A** solid **B** solid **C** solid **D**

He dissolves each solid in water to make a solution.

He tests each solution and records the results in a table.

Look at his results.

Test	**Result with A**	**Result with B**	**Result with C**	**Result with D**
Reaction with barium chloride solution	no precipitate	no precipitate	white precipitate	white precipitate
Reaction with silver nitrate solution	cream precipitate	white precipitate	no precipitate	white precipitate
Reaction with sodium hydroxide solution	colourless solution	blue precipitate	blue precipitate	green precipitate

Oskar makes a conclusion.

Which solid was a mixture of two compounds?

Explain how Oskar came to this conclusion.

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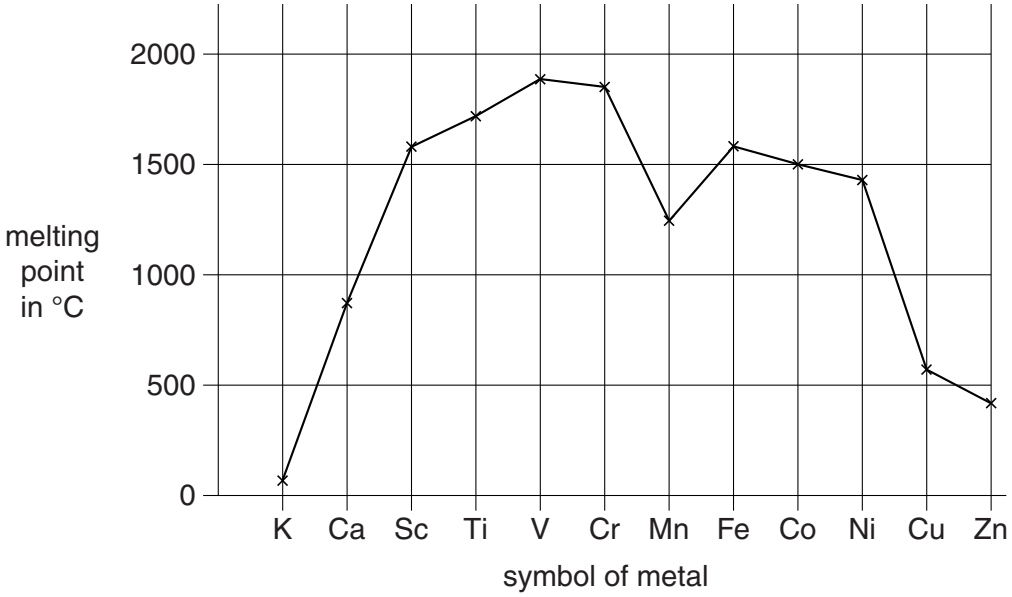
..... **[3]**

[Total: 3]

5 Most metals have high melting points.

Look at the graph. It shows the melting points of some metals.



(a) Write the symbol of the metal which has the **weakest** metallic bonds.

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

(b) Describe, using a labelled diagram, what is meant by metallic bonding.

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

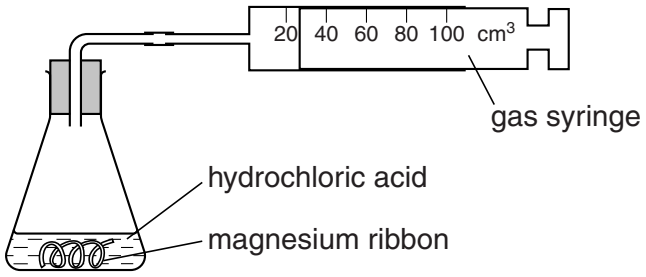
[Total: 3]

SECTION B – Module C5

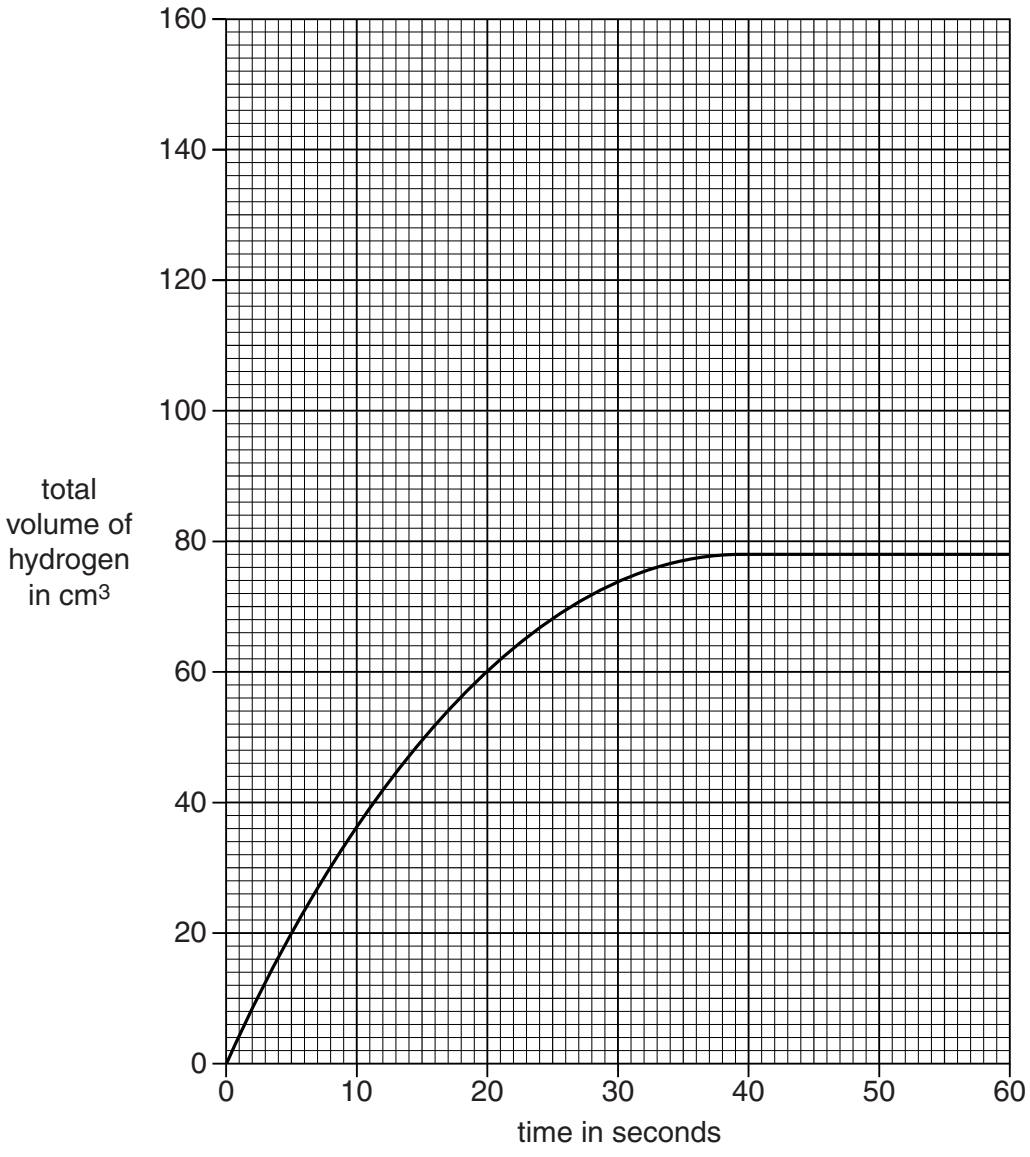
6 Trevor and Julie investigate the reaction between magnesium and hydrochloric acid at 20 °C.

magnesium + hydrochloric acid → magnesium chloride + hydrogen

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



Look at the graph. It shows their results.



(a) (i) What is the volume of hydrogen made after 25 seconds?

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

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

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

(iii) Trevor and Julie repeat the experiment.

They keep everything the same except the temperature.

They increase the temperature from 20 °C to 35 °C.

On the grid, sketch the graph of the results they should get. **[1]**

(b) Magnesium is the **limiting reactant** in this reaction.

What is meant by limiting reactant?

.....

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

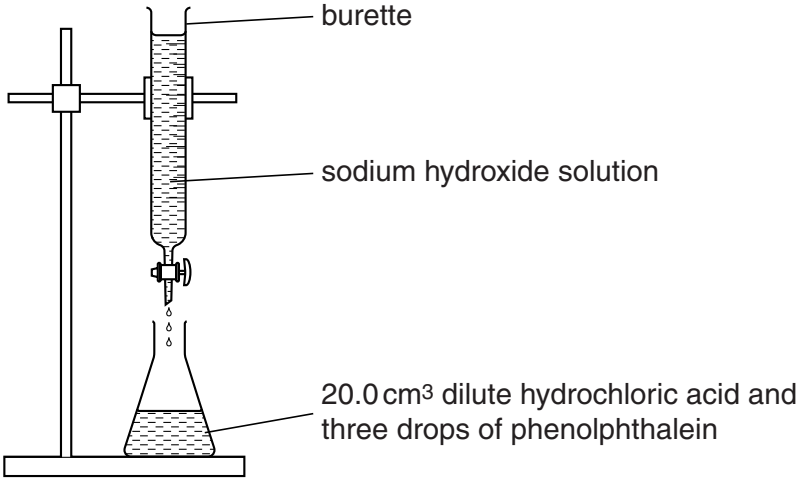
[Total: 4]

7 This question is about acid-base titrations.

Brian neutralises dilute hydrochloric acid with sodium hydroxide solution.

He wants to find out the concentration of the sodium hydroxide solution.

Look at the apparatus.



Brian adds sodium hydroxide solution slowly until the phenolphthalein changes colour.

He does the titration four times.

Look at Brian's results.

Titration number	**1**	**2**	**3**	**4**
Volume of sodium hydroxide added in cm^3	25.9	24.9	25.1	25.0

Brian calculates the mean volume of sodium hydroxide solution to be 25.0 cm^3.

(a) Titration **1** was not included in the calculation of the mean volume of sodium hydroxide added.

Suggest why.

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

(b) Look at the equation for the reaction.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

The mean volume of sodium hydroxide solution used is 25.0 cm^3.

Brian uses 20.0 cm^3 of hydrochloric acid.

The concentration of the hydrochloric acid is 0.100 mol/dm^3.

Calculate the concentration of the sodium hydroxide in mol/dm^3.

answer ..... mol/dm^3 **[3]**

(c) Phenolphthalein is a single indicator.

Universal indicator is a mixed indicator.

Explain why Brian used phenolphthalein rather than universal indicator.

.....

.....

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

[Total: 6]

8 Ammonia is made from nitrogen and hydrogen in an equilibrium reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is **exothermic**.

Look at **Table 1**.

It shows the percentage of ammonia in the equilibrium mixture at 450 °C and different **pressures**.

Pressure in atmospheres	**Percentage (%) of ammonia at 450 °C**
1	0.2
50	9.5
100	16.2
200	25.3

Table 1

Look at **Table 2**.

It shows the percentage of ammonia in the equilibrium mixture at 300 atmospheres and different **temperatures**.

Temperature in °C	**Percentage (%) of ammonia at 300 atmospheres**
400	50
450	35
500	25
550	17

Table 2

13

Describe and explain how changing the pressure and changing the temperature affect the position of equilibrium in the reaction between nitrogen and hydrogen.

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

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

[Total: 6]

9 Look at the table.

It shows information about the contents of some foods on food labels.

It also shows the Guideline Daily Amounts (GDA) for an adult.

Food contents	**Small pizza**	**Chicken curry**	**Fish in cheese sauce**	**GDA for an adult**
Energy in calories	396	384	200	2000
Protein in g	16.9	41.4	22.8	45
Carbohydrate in g	51.3	11.0	2.9	230
Fat in g	13.7	19.2	10.8	70
Sodium in g	0.7	0.9	0.4	2.3

(a) Look at the information for the chicken curry.

What percentage of the GDA for **fat** is in the chicken curry?

answer ..... % **[2]**

(b) The chicken curry contains 1.17 g of salt.

Salt is sodium chloride, NaC*l*.

(i) Calculate the mass of sodium in 1.17 g of salt.

Give your answer correct to **2 significant figures**.

The relative atomic mass, A_r, of Na is 23 and of C*l* is 35.5.

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

(ii) Why is the value that you calculated in part **(i)** less than the value in the table?

.....

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

[Total: 4]

10 Hydrochloric acid is a **strong** acid.

Ethanoic acid is a **weak** acid.

Both acids contain hydrogen ions, H^+.

(a) Explain why hydrochloric acid is a strong acid and ethanoic acid is a weak acid.

.....

.....

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

(b) An excess of both acids react with 0.1 g of magnesium to make hydrogen gas.

Both acids have a concentration of 1 mol / dm^3.

(i) Ethanoic acid reacts more slowly with magnesium than hydrochloric acid.

Explain why.

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

(ii) Both reactions make the same volume of hydrogen.

Explain why.

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

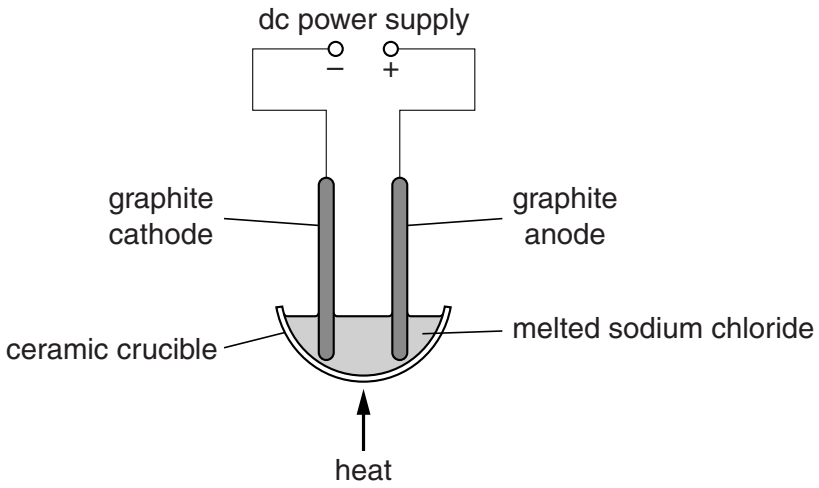
[Total: 5]

SECTION C – Module C6

11 This question is about electrolysis.

(a) Joel's teacher investigates the electrolysis of melted sodium chloride.

Look at the apparatus he uses.



Sodium chloride contains sodium ions, Na^+, and chloride ions, Cl^-.

(i) Chloride ions, Cl^-, react at the anode.

Chlorine gas, Cl_2, and electrons are the products.

Write a **balanced symbol** equation for the electrode process at the anode.

Use **e⁻** to show an electron.

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

(ii) **Solid** sodium chloride does **not** conduct electricity, but **melted** sodium chloride **does** conduct electricity.

Explain why.

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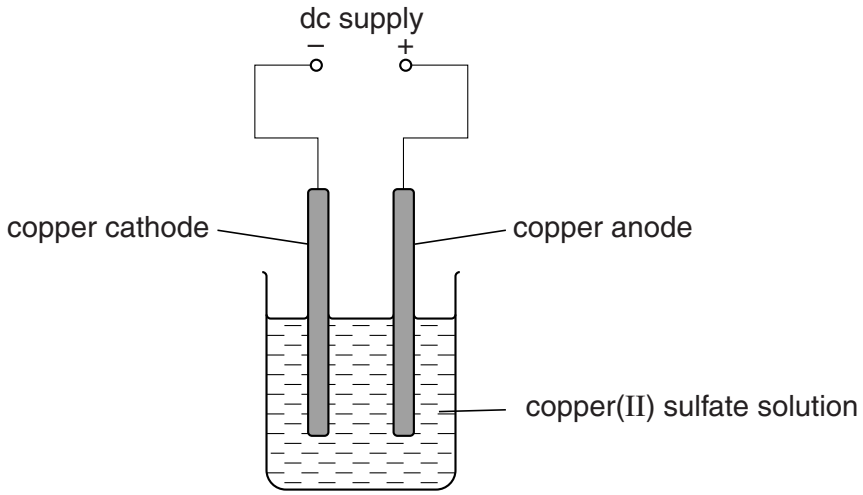
..... **[2]**

(b) Joel passes an electric current through **copper(II) sulfate solution**.



Joel does four experiments.

Joel changes either the **time** or the **current**.

Copper is made at the cathode.

He measures how much copper is made in each experiment.

Experiment	Current in amps	Time in minutes	Mass of copper made in g
1	0.15	5	0.20
2	0.30	5	0.40
3	0.15	10	0.40
4	0.60	10	1.60

Joel concludes that the amount of copper made is **proportional** to both the current and to the time.

Show how the results support this conclusion.

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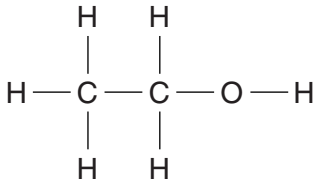
..... **[2]**

[Total: 6]

12 Ethanol, propanol and butanol are alcohols.

Look at the displayed formula of ethanol.



(a) Ethanol is made by the hydration of ethene, C_2H_4.

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

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

(b) Alcohols have the general formula $C_nH_{2n+1}OH$.

(i) A molecule of propanol has **3** carbon atoms.

Write the formula of propanol.

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

(ii) Draw the **displayed** formula of butanol, C_4H_9OH.

[1]

(c) Ethanol is also made by fermentation of sugars in a batch process.

The table compares making ethanol by hydration and by fermentation.

	Hydration	**Fermentation**
Raw materials	ethene from crude oil	sugar from plants
Type of process	continuous	batch
Rate of reaction	fast	slow
Conditions used	high temperature, 300 °C, high pressure, 60 atm, and a catalyst	low temperature, 40 °C, atmospheric pressure and an enzyme in yeast acts as a catalyst
Purity of product	pure	impure
Atom economy	100%	51%

Evaluate the advantages and disadvantages of each method.

Which method do you think is the best for manufacturing ethanol in the UK?

Explain why.

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

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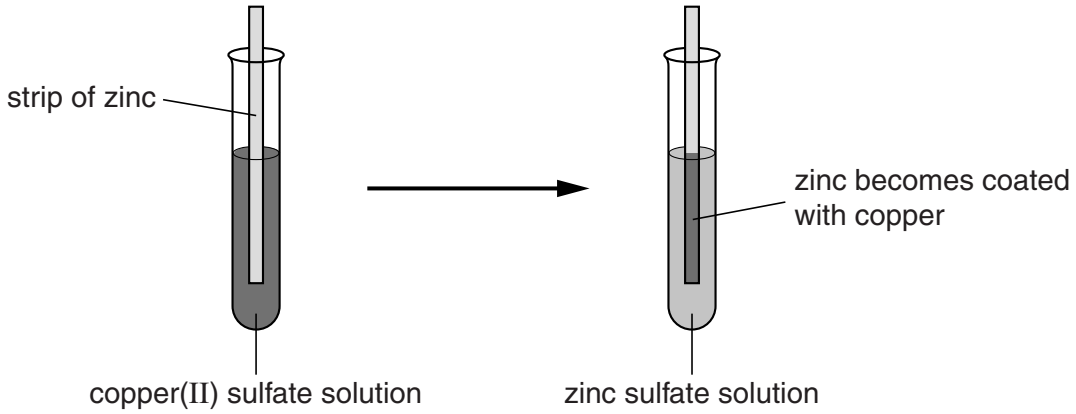
..... **[6]**

[Total: 9]

13 Jill investigates the reactivity of some metals.

Look at the diagram. It shows what happens when she puts a strip of zinc into copper(II) sulfate solution.



(a) Write the **word** equation for the reaction between zinc and copper(II) sulfate solution.

..... + ... → ..... + ...
....

[1]

(b) Iron rusts in the presence of oxygen and water.

Look at the equations for two reactions that happen during rusting.

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

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

Which reaction is oxidation and which is reduction?

Explain your answer.

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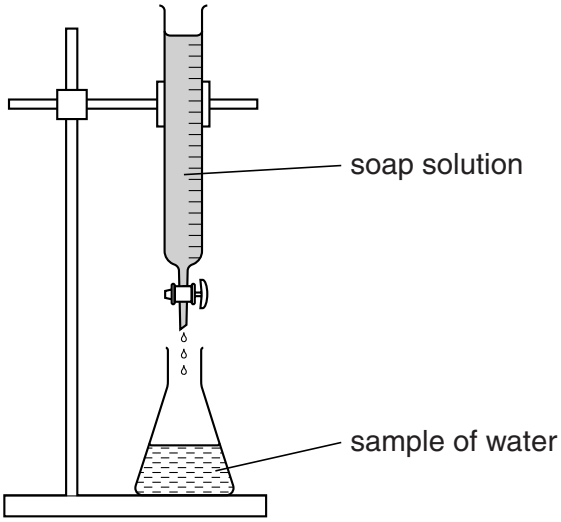
..... **[2]**

[Total: 3]

14 This question is about hard and soft water.

(a) Jean investigates the hardness of three different samples of water.

Look at the diagram of the apparatus she uses.



Jean adds drops of soap solution to the same volume of each sample of water.

After each drop she shakes the flask to see if a lather is made.

She adds more drops of soap until a lather remains on the surface.

Look at her results.

Sample of water	Volume of soap added in cm^3
tap water	28
boiled tap water	10
distilled water	1

What conclusion can you make about the types of hardness in tap water?

Explain your answer.

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

Turn over for the remainder of question 14

(b) One way of softening water is to use an ion-exchange resin.

The resin contains sodium ions, Na^+.

When hard water goes through the resin the water becomes soft.

Explain how an ion-exchange resin softens water.

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

[Total: 4]

15 Chlorofluorocarbons, CFCs, were used in the 1970s.

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

(a) Explain why the use of CFCs has been banned.

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.....

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

(b) CFCs have now been replaced by other compounds.

Choose from the list one compound that has replaced CFCs.

CCl_3F

C_2HF_5

C_2ClF_5

CCl_2F_2

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

[Total: 3]

SECTION D

16 Scientists are concerned about the pollution of both the air and water.

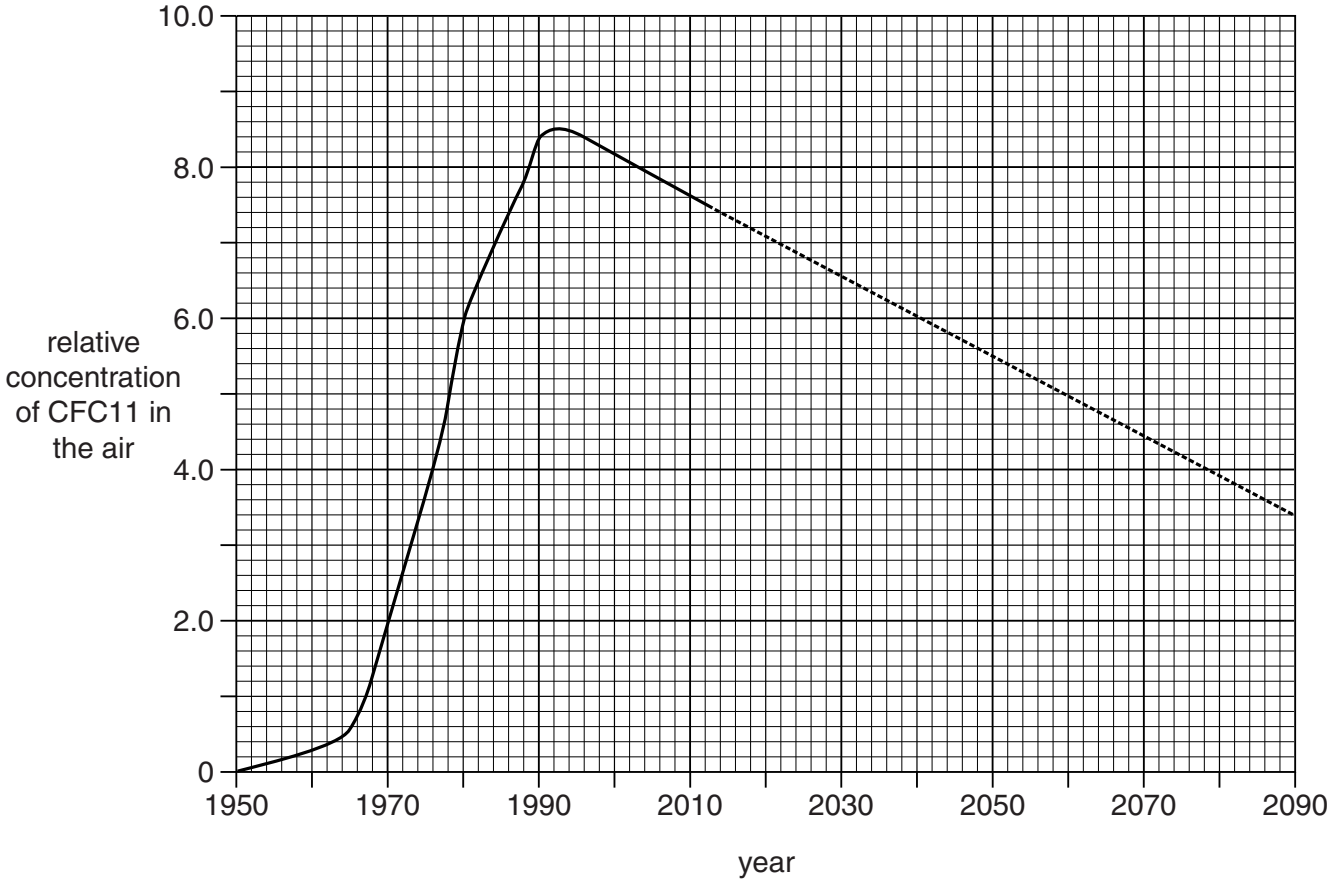
Chlorofluorocarbons, CFCs, are pollutants found in the air.

CFC11 is a chlorofluorocarbon.

Look at the graph.

It shows how the concentration of CFC11 in the air has changed between 1950 and 2013.

The dotted line shows how it may change up to 2090.



(a) In 1989, some countries banned the use of CFCs.

(i) Look at the graph.

Estimate the year when the concentration of CFC11 will drop to 50% of the 2003 value.

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

(ii) Nick estimates that CFC11 molecules remain in the atmosphere for 45 years.

Is this value consistent with the data shown on the graph?

Explain your answer.

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

(iii) It is difficult to predict how the concentration of CFC11 in the air will change in the future.

Suggest **two** reasons why.

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

(b) CFC11 dissolves in rainwater.

Some rainwater collects underground.

Once underground, the concentration of CFC11 in the water does not change.

In 2013, a scientist analyses some underground rainwater.

She finds that the CFC11 concentration in the air, when the rain fell, was 2.0 units.

Use the graph to decide how many years this rainwater has been underground.

.....

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

(c) CFC12 is another chlorofluorocarbon.

Look at the table. It shows how the concentration of **CFC12** has changed between 1950 and 2010.

Year	Relative concentration of CFC12 in the air
1950	0
1960	0.1
1970	1.5
1980	4.0
1990	4.4
2000	4.5
2010	4.4

(i) What is the percentage decrease in CFC12 concentration in the air from the year 2000 to 2010?

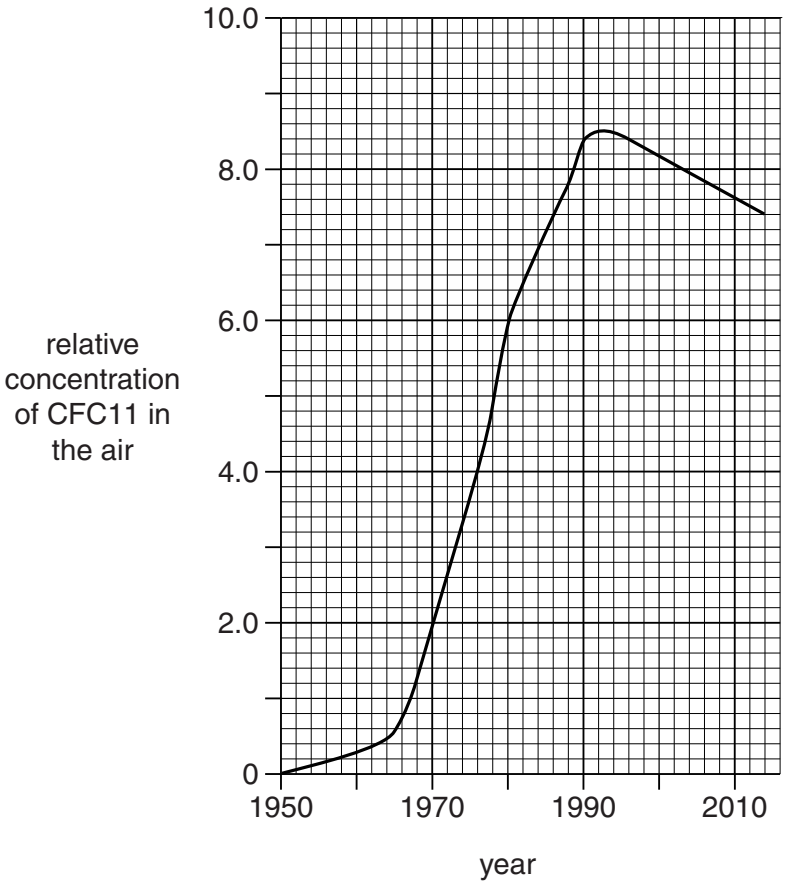
.....

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

(ii) Many countries signed an international agreement to ban the use of CFCs in 1989.

Look at this graph.

It shows how the concentration of **CFC11** in the air has changed between 1950 and 2010.



Did the ban on the use of CFCs have the same effect on the concentration in the air of CFC11 as on CFC12?

Explain your answer.

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

[Total: 10]

END OF QUESTION PAPER

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.