

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GCSE

B742/02

GATEWAY SCIENCE
CHEMISTRY B

Chemistry modules C4 C5 C6
(Higher Tier)

THURSDAY 13 JUNE 2013: Morning

DURATION: 1 hour 30 minutes
plus your additional time allowance

MODIFIED ENLARGED

Candidate forename		Candidate surname	
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Centre number						Candidate number				
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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)

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

- **Write your name, centre number and candidate number in the boxes on the first page. 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).**

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.**
- **Any blank pages are indicated.**

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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
${}^1_1\text{H}$	1	0	1
${}^2_1\text{H}$	1	1	1
${}^{31}_{15}\text{P}$	15	16	15
_____	15	17	15
${}^{32}_{16}\text{S}^{2-}$	_____	16	16

(a) Complete the table.

[2]

(b) ${}^1_1\text{H}$ and ${}^2_1\text{H}$ are ISOTOPES of hydrogen.

What is meant by the term ISOTOPE?

_____ **[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?

[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, **Cl₂**, is a covalent molecule.

Use the 'dot and cross' model to describe the bonding in a molecule of chlorine, **Cl₂**.

You only need to draw the outer shell electrons.

[2]

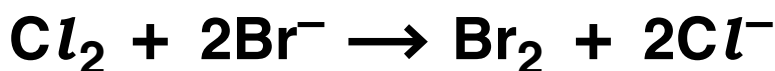
- (c) Sodium chloride, **NaCl**, contains sodium ions, **Na⁺**, and chloride ions, **Cl⁻**.

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

[2]

- (d) Chlorine reacts with sodium bromide solution.

Look at the IONIC equation for this reaction.



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.

[6]

[TOTAL: 6]

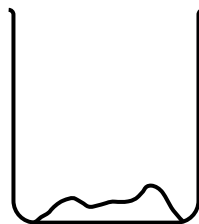
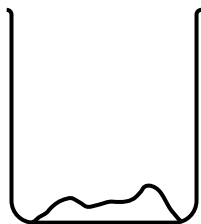
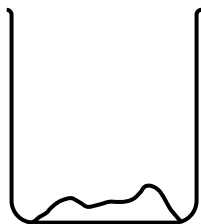
4 Oskar has four beakers containing different solids.

solid A

solid B

solid C

solid D



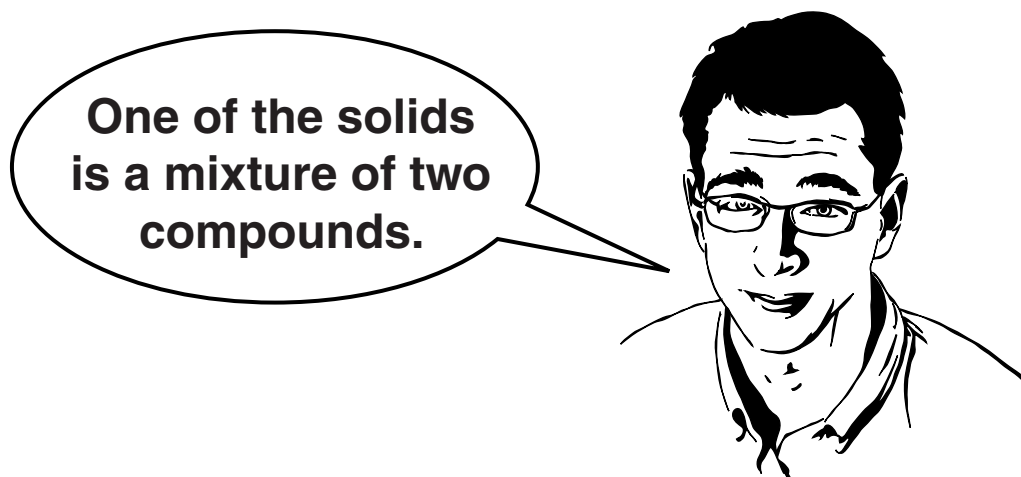
He dissolves each solid in water to make a solution.

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

Look at his results (opposite).

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.

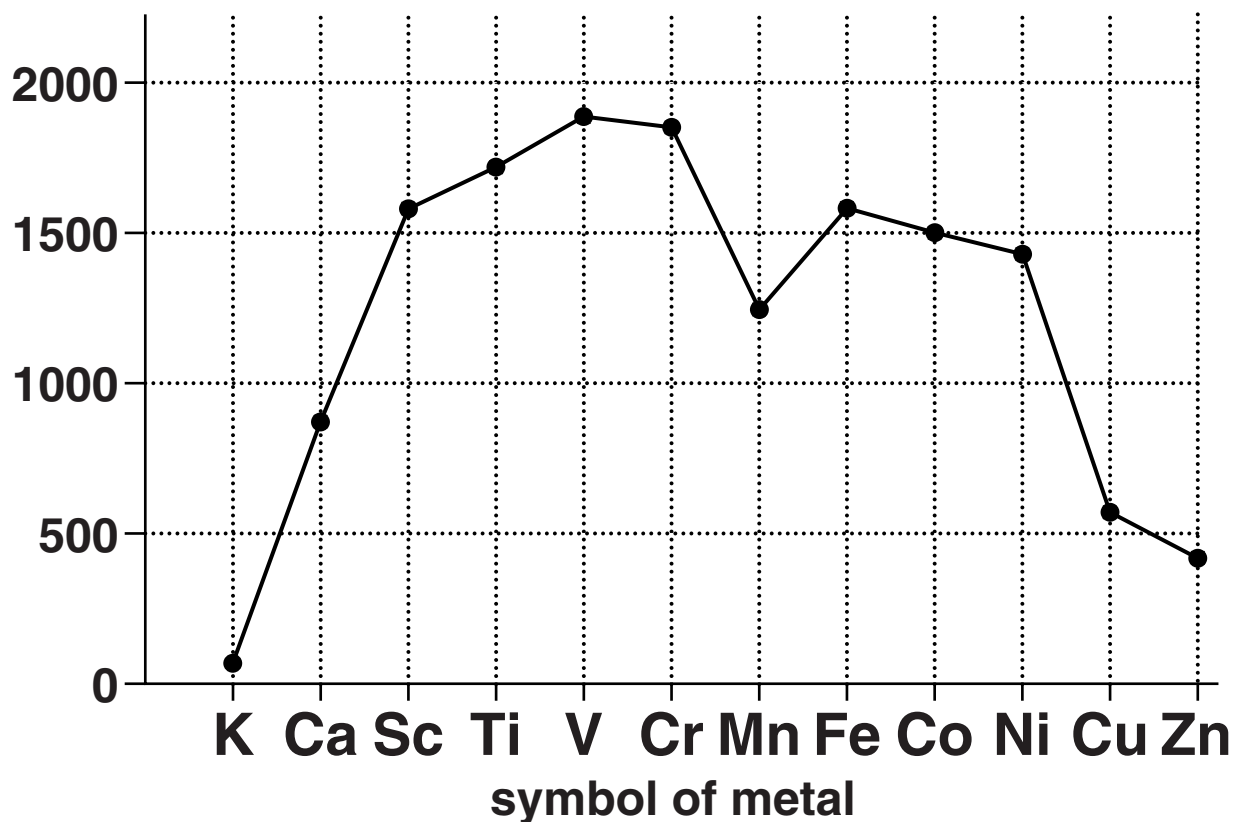
[3]

[TOTAL: 3]

5 Most metals have high melting points.

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

melting point in °C



(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.

[2]

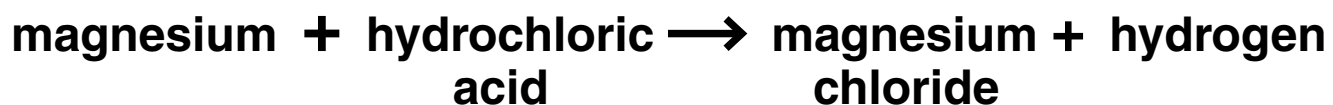
[TOTAL: 3]

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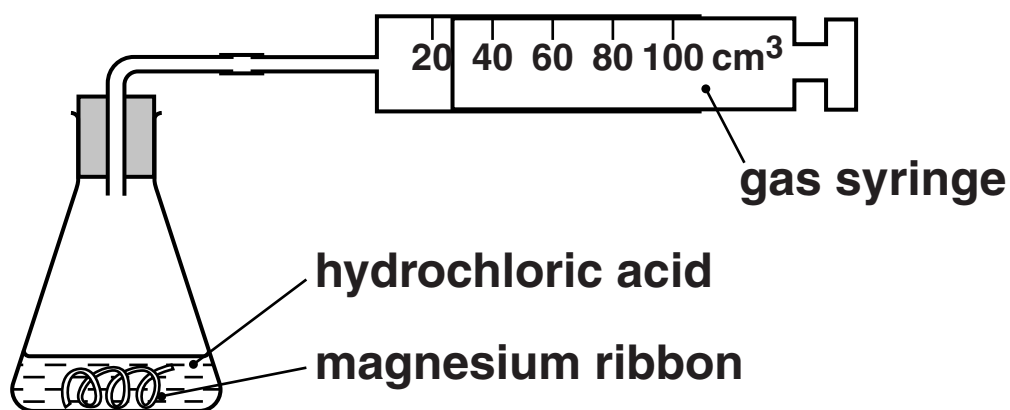
SECTION B BEGINS ON PAGE 16

SECTION B – MODULE C5

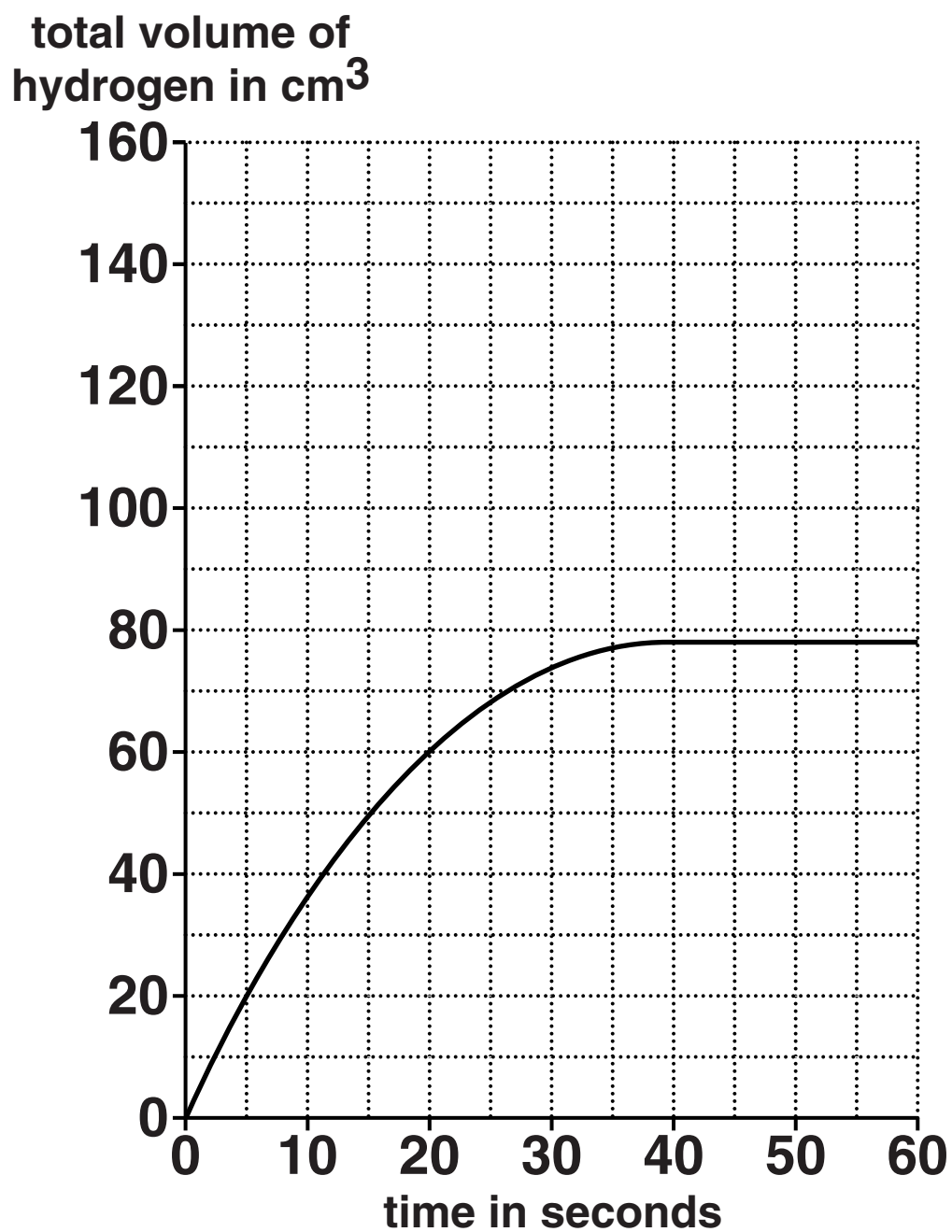
- 6 Trevor and Julie investigate the reaction between magnesium and hydrochloric acid at 20 °C.



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 _____ cm³ [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]

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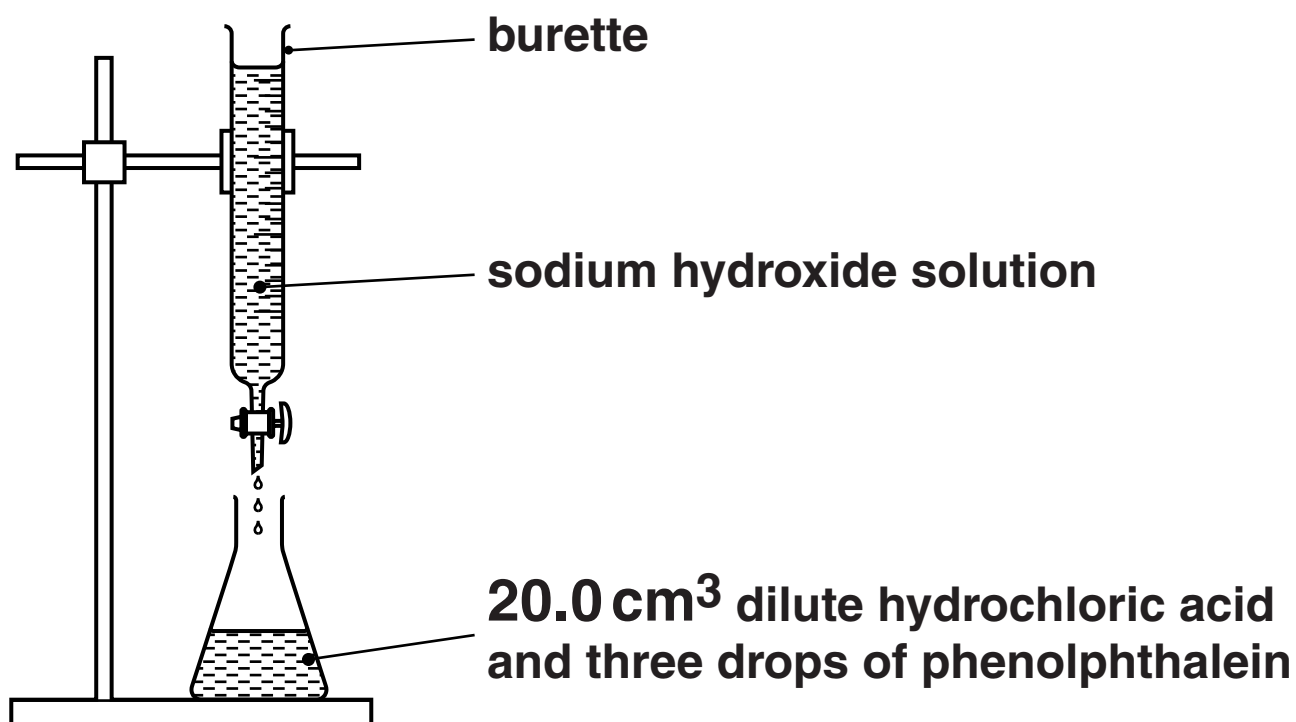
QUESTION 7 BEGINS ON PAGE 20

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 cm³	25.9	24.9	25.1	25.0

Brian calculates the mean volume of sodium hydroxide solution to be 25.0 cm³.

(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.



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.



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.

TABLE 1

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

Look at TABLE 2.

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

TABLE 2

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

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.

[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, NaCl.

(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 Cl 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.

[2]

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

Explain why.

[1]

[TOTAL: 5]

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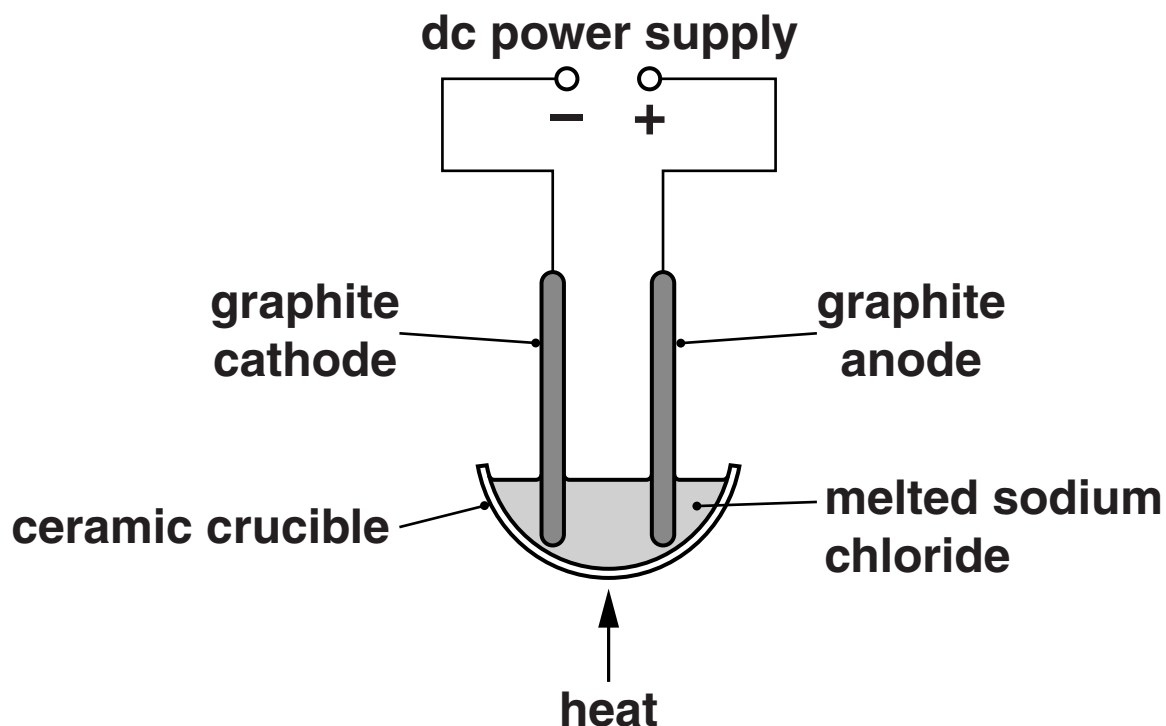
SECTION C BEGINS ON PAGE 32

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.

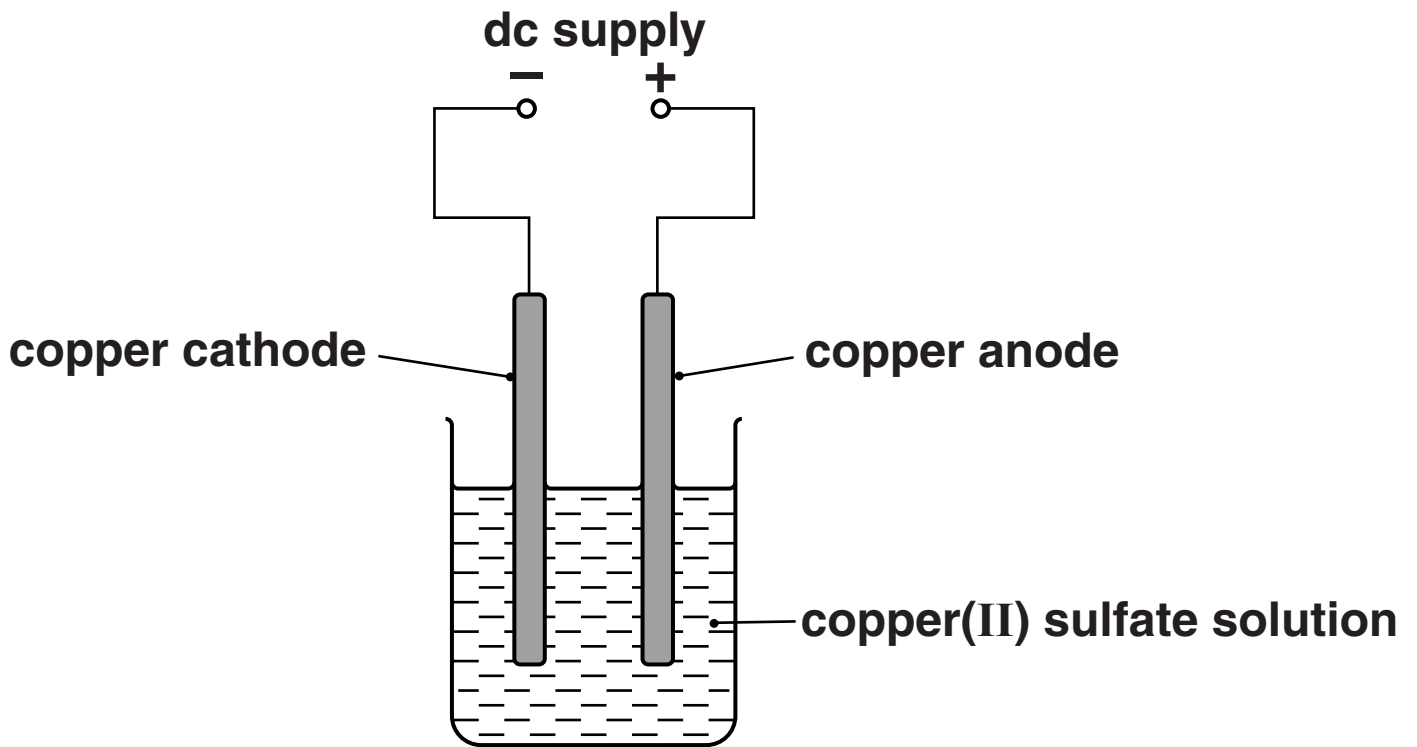
_____ [2]

(ii) **SOLID** sodium chloride does **NOT** conduct electricity, but **MELTED** sodium chloride **DOES** conduct electricity.

Explain why.

_____ [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.

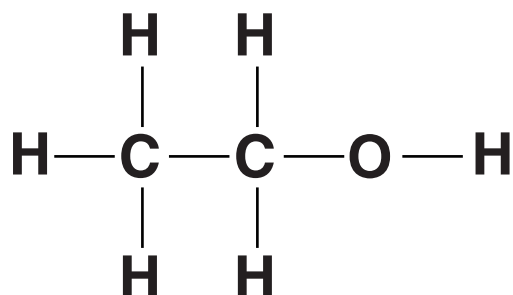
Show how the results support this conclusion.

[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 $\text{C}_n\text{H}_{2n+1}\text{OH}$.

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

Write the formula of propanol.

_____ [1]

(ii) Draw the DISPLAYED formula of butanol, $\text{C}_4\text{H}_9\text{OH}$.

[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.

[6]

[TOTAL: 9]

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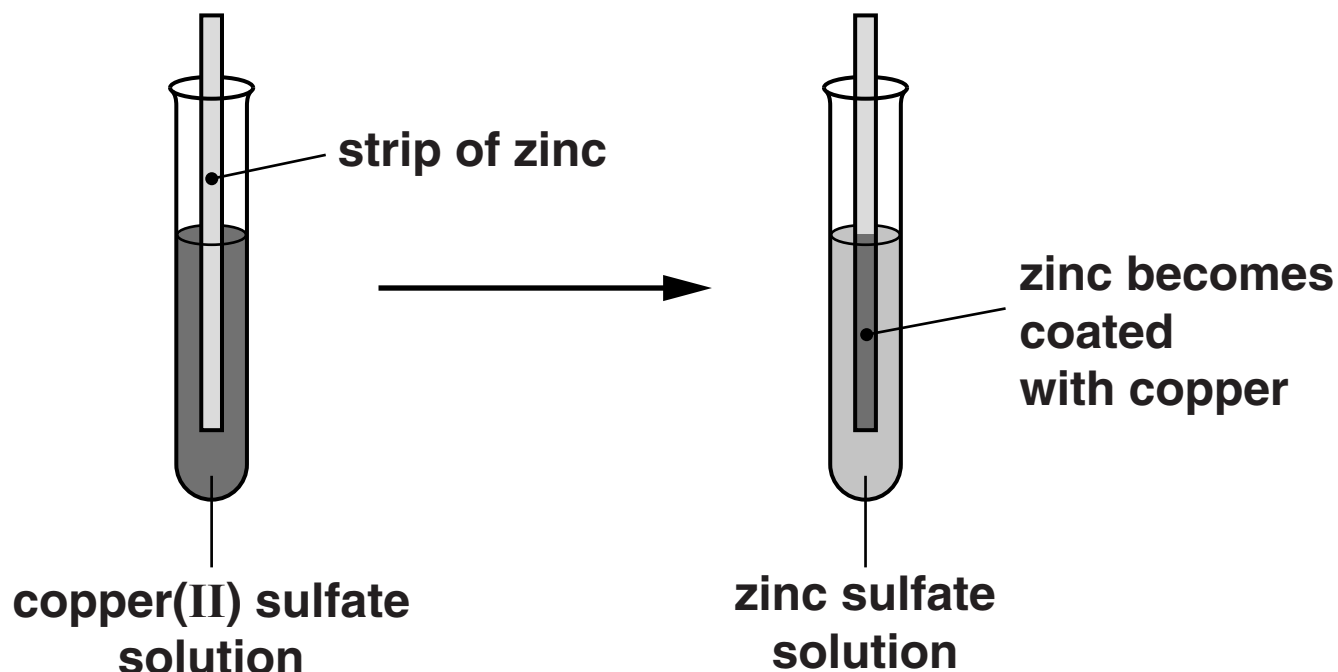
QUESTION 13 BEGINS ON PAGE 40.

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.

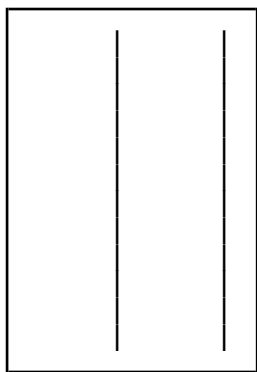
start of experiment

end of experiment

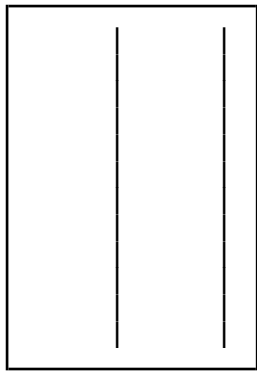
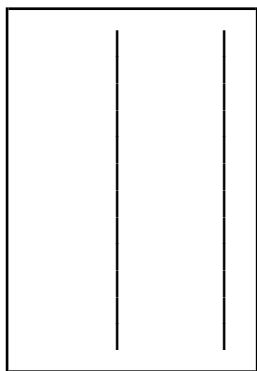


(a) Write the WORD equation (opposite) for the reaction between zinc and copper(II) sulfate solution.

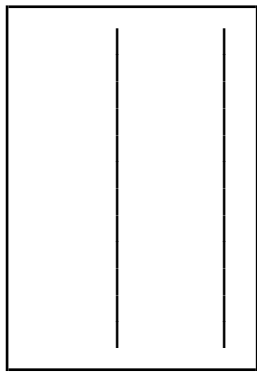
[1]



+

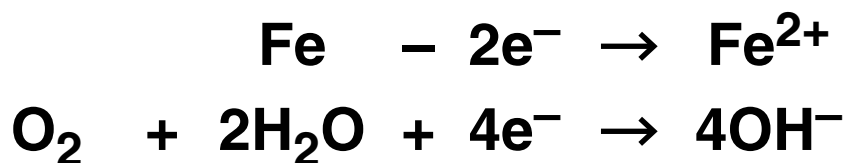


+



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

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



Which reaction is oxidation and which is reduction?

Explain your answer.

[2]

[TOTAL: 3]

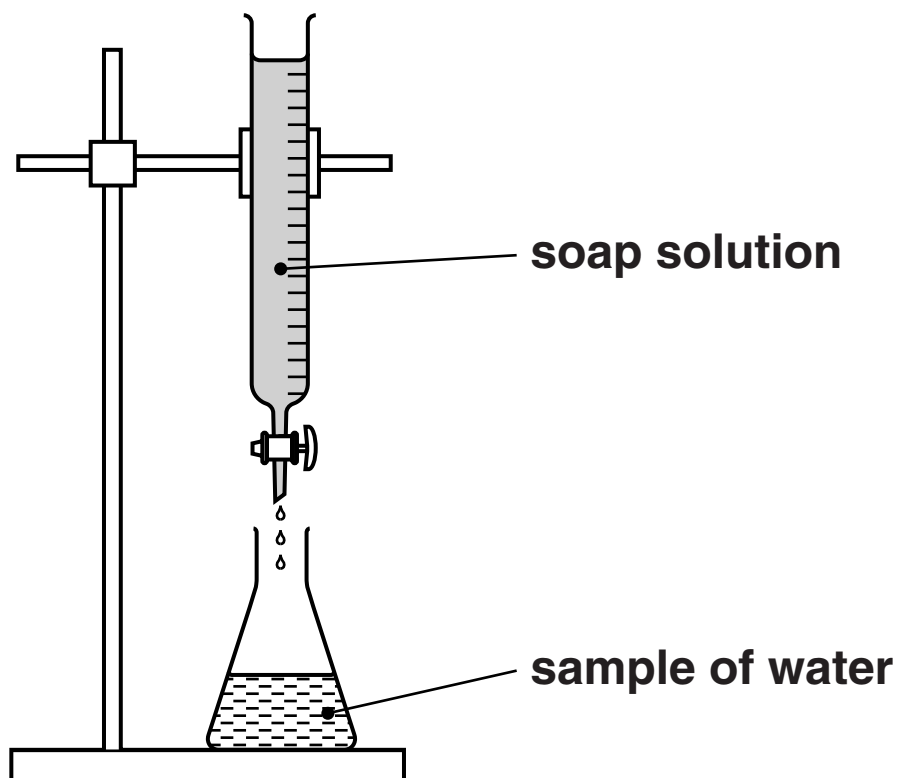
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QUESTION 14 BEGINS ON PAGE 44

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 cm³
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.

[2]

(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.

[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.

[2]

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

Choose from the list one compound that has replaced **CFCs**.



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.

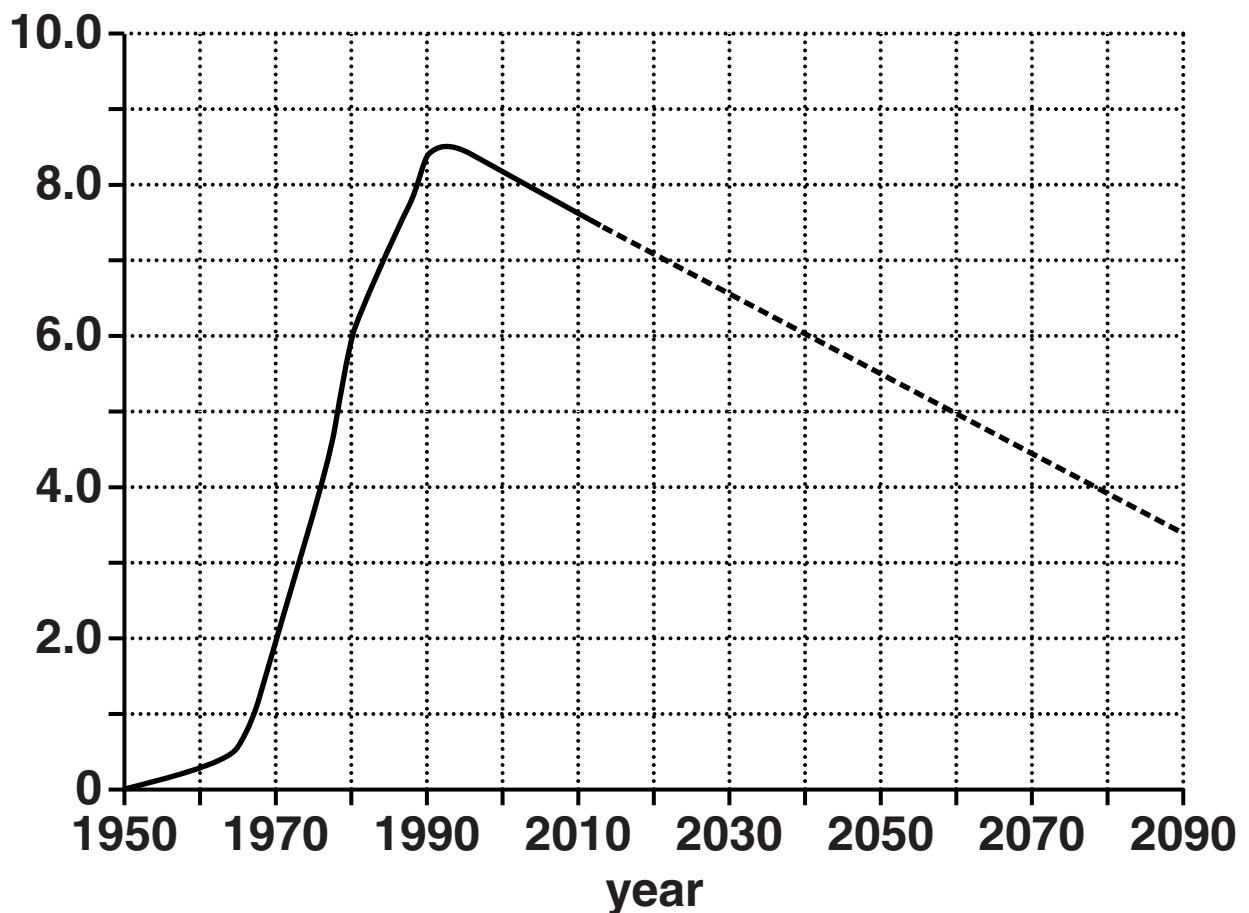
CFC11 is a chlorofluorocarbon.

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.

relative concentration of
CFC11 in the air



(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.

_____ [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.

_____ [1]

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

Suggest TWO reasons why.

[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?

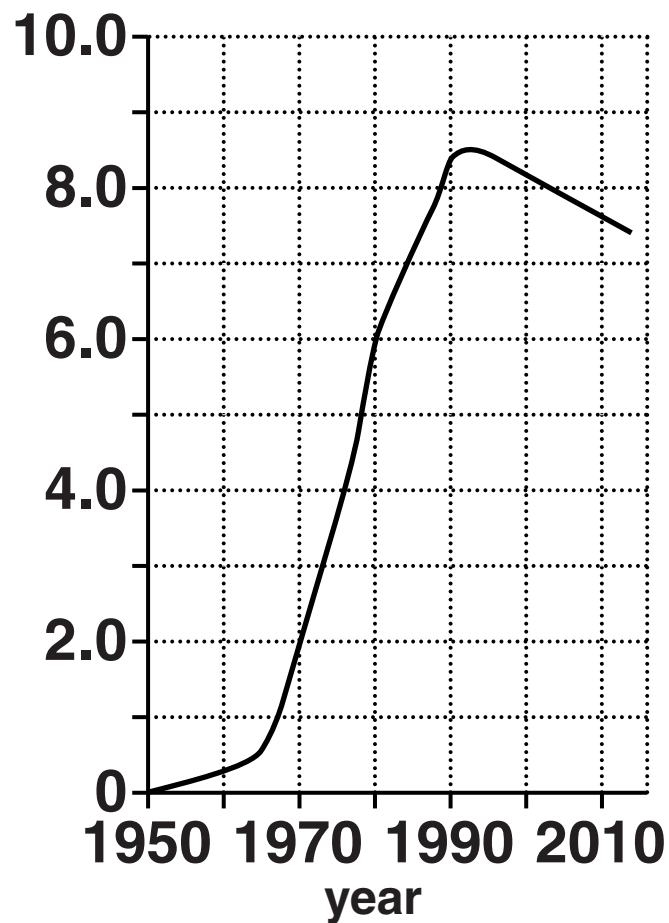
[1]

- (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.

relative concentration
of **CFC11** in the air



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.

[2]

[TOTAL: 10]

END OF QUESTION PAPER

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The Periodic Table of the Elements

1	2	Key										3	4	5	6	7	0
		relative atomic mass atomic symbol name atomic (proton) number															
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

1
H
hydrogen
1

* 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.