OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



EXAM QUESTION PACK

C6.3 INTERPRETING AND INTERACTING WITH EARTH SYSTEMS

SCORE	PERCENTAGE
/254	%

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Gateway Chemistry A (9-1)

Interpreting and interacting with Earth systems

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

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, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- 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 **254**.
- The total number of marks may take into account some 'either/or' question choices.

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1 Ammonium phosphate is used as a fertiliser.

The formula for ammonium phosphate is:

$(NH_4)_3PO_4$

Which elements in ammonium phosphate are **essential elements** for plant growth?

A nitrogen and hydrogen
B nitrogen and phosphorus
C hydrogen and oxygen
D phosphorus and oxygen

Your answer ☐

[1]

2 In some remote islands, drinking water is made from sea water.

What is the name of the process for making drinking water from sea water?

A chlorination
B distillation
C filtration
D sedimentation

Your answer ☐

[1]

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3(a) Ammonium sulfate, $(NH_4)_2SO_4$, is a fertiliser.

Ammonium sulfate can be manufactured from ammonia and sulfuric acid.

Sulfuric acid is manufactured in a series of steps.

Step 1:
Sulfur is burnt in oxygen to produce sulfur dioxide.

Step 2, The Contact Process:
Sulfur dioxide is reacted with oxygen to produce sulfur trioxide. This takes place in the presence of vanadium(V) oxide at a pressure of 2 atmospheres and at about 450°C.

Step 3:
Sulfur trioxide is reacted with water to produce sulfuric acid.

Write balanced symbol equations for each stage of this process.

---

[4]

(b) Ammonium sulfate is a salt.

It is manufactured using the reaction between the alkali ammonia and sulfuric acid.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

What type of reaction is this?

---

[1]

4(a) Carbon dioxide is one of several greenhouse gases.

It is made by the combustion of fossil fuels such as coal, gas and oil.

Look at the table. It shows the amount of carbon dioxide produced in a large city between the years 2010 and 2016.

Source of carbon dioxide	Carbon dioxide produced (tonnes)		Percentage increase (%)
	in 2010	in 2016	
Homes	500 000	600 000	20
Factories and industry	500 000	750 000	50
Transport	1 000 000	1 000 000	0
Electricity generation	750 000	900 000	.....

Look at the row for electricity generation.

Calculate the percentage increase of carbon dioxide produced.

Percentage increase = _____ % [2]

(b) Analyse the data in the table.

What is the ratio of carbon dioxide produced from **Homes** to **Electricity generation** for 2016?

---[2]

(c) The population of the city increased between 2010 and 2016.

The carbon dioxide produced from Transport has not changed between 2010 and 2016.

Why has the carbon dioxide production from Transport remained the same?

Give **two** conclusions.

---

[2]

5 These statements explain how scientists think our modern-day atmosphere was formed.

1 Plants evolved and used carbon dioxide during photosynthesis to make oxygen.
2 As the Earth cooled down water fell as rain resulting in the formation of the oceans.
3 The atmosphere today consists of nitrogen, oxygen and a small amount of carbon dioxide.
4 Volcanoes gave out ammonia and carbon dioxide as well as methane and water vapour.
5 Ammonia was changed by bacteria in the soil into nitrogen gas.

What is the correct order that these events happened?

A 4, 2, 5, 1, 3
B 2, 4, 5, 3, 1
C 4, 1, 5, 2, 3
D 1, 4, 2, 5, 3

Your answer ☐

[1]

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6 Ammonium sulfate is a salt.

It is made using the reaction between the alkali ammonia and sulfuric acid.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

(i) Describe how a sample of solid ammonium sulfate is prepared in a laboratory.

Explain why this method is not suitable to be used industrially.

---

[4]

(ii) Predict the maximum mass of ammonium sulfate that can be made from 51 tonnes of ammonia.

Maximum mass = _____ tonnes [2]

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7(a) Carbon dioxide is one of several greenhouse gases.

It is made by the combustion of fossil fuels such as coal, gas and oil.

Look at the table. It shows the amount of carbon dioxide produced in a large city in the years 2010 and 2016.

Between the years 2010 and 2016 the percentage increase of atmospheric carbon dioxide has been about 2.5%. During the same time, the increase in mean global temperature has been only 0.05°C.

Source of carbon dioxide	Carbon dioxide produced (tonnes)		Percentage increase (%)
	in 2010	in 2016	
Homes	500 000	600 000	20
Factories and industry	500 000	750 000	50
Transport	1 000 000	1 000 000	0
Electricity generation	750 000	900 000	.....

Look at the row for electricity generation.

Calculate the percentage increase of carbon dioxide produced.

Percentage increase = _____ % [2]

(b) Some scientists think there is a link between the amount of fossil fuels burnt and climate change.

The data in the table does **not** support this view.

Suggest reasons why.

---[2]

8(a) Farmers use fertilisers to improve crop yield.

Fertilisers contain one or more of the three essential elements.

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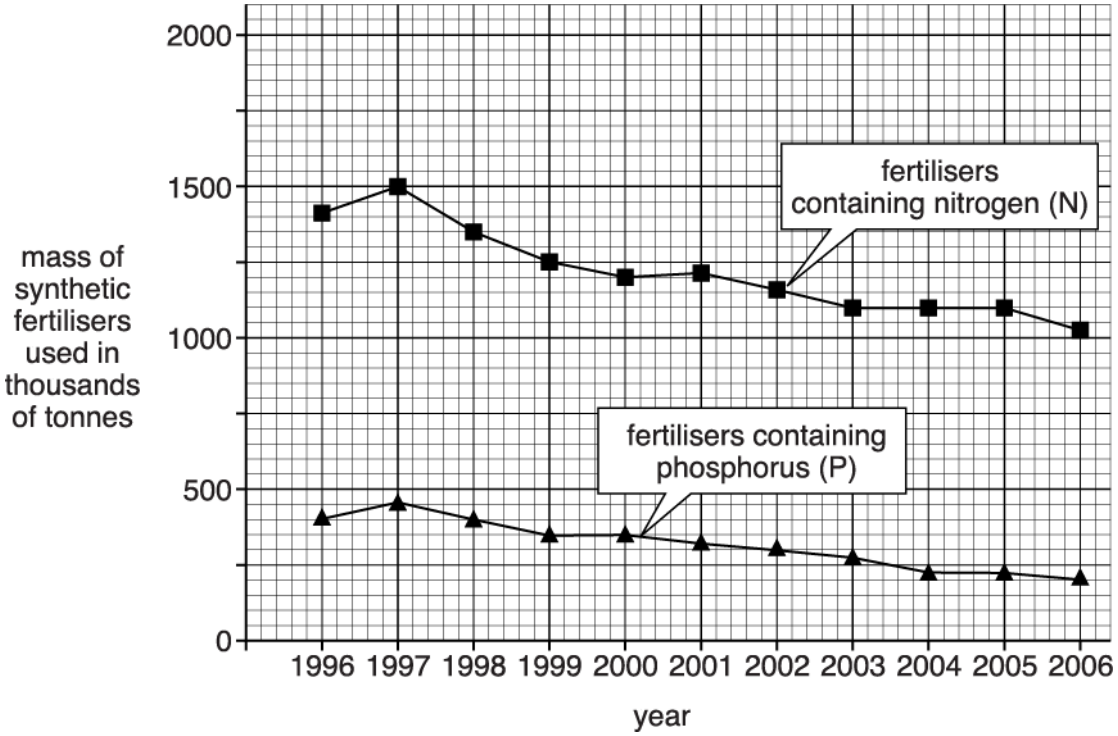
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These essential elements are nitrogen, phosphorus and potassium.

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

Look at the graph.

It shows the use of some synthetic fertilisers in the UK between 1996 and 2006.



(i) What mass of fertilisers containing **nitrogen** was used in 1997?

_____ thousands of tonnes

[1]

(ii) Describe the general trend in the use of these synthetic fertilisers in the UK from 1996 to 2006.

---

[1]

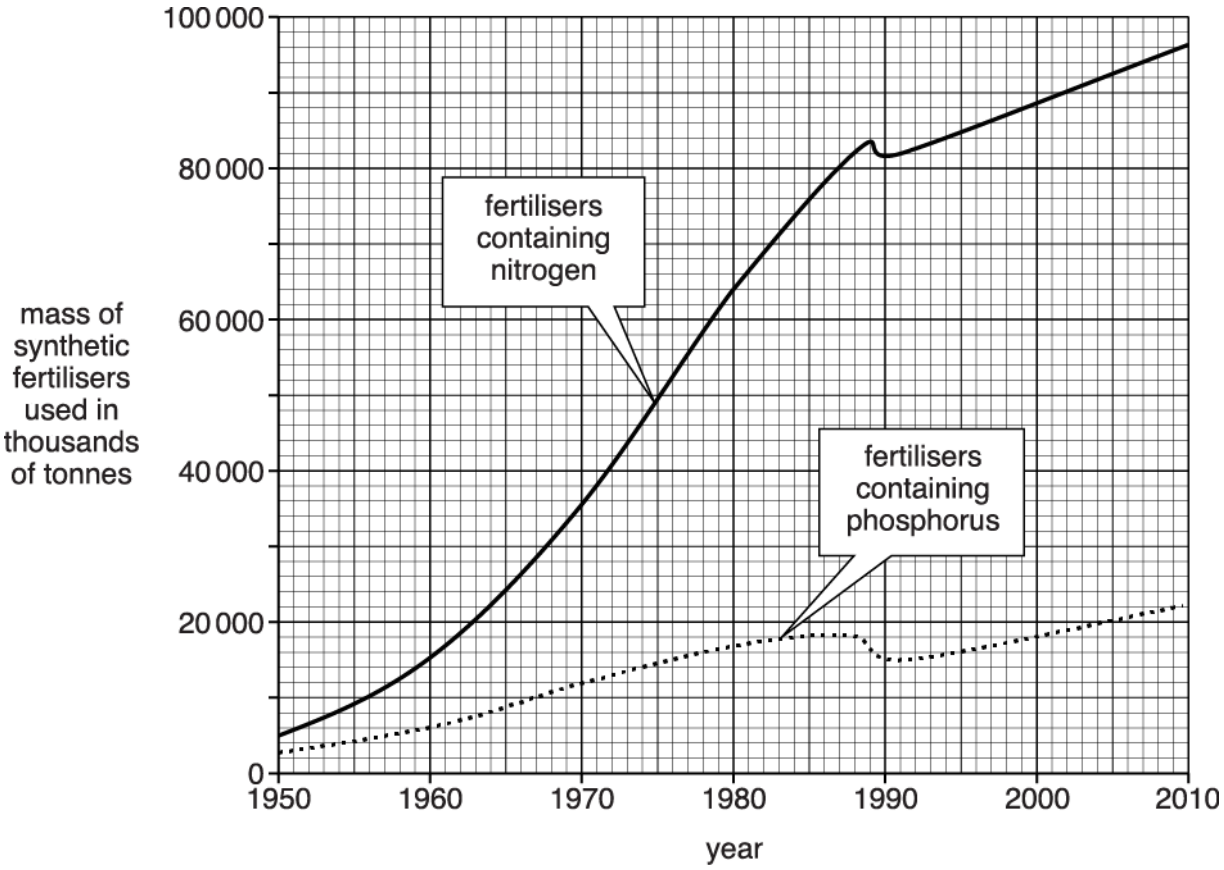
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(b) Look at the graph.

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



Use the graphs in **(a)** and **(b)** to **compare** the use of synthetic fertilisers in the UK and the world.

---

[3]

(c) 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 in kg	Mass of pesticides used in 1 km^2 in kg
A	39000	5100
B	59000	200
C	45000	900
D	8000	500
E	6000	200

(i) Some people want to buy organic vegetables.

Organic vegetables must be grown **without** the use of synthetic fertilisers and pesticides.

From the information in the table, suggest a country, **A, B, C, D** or **E** which grows lots of organic vegetables.

Explain your answer.

---

[2]

(ii) The land area of country **B** is 7 000 000 km^2.

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

---

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

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

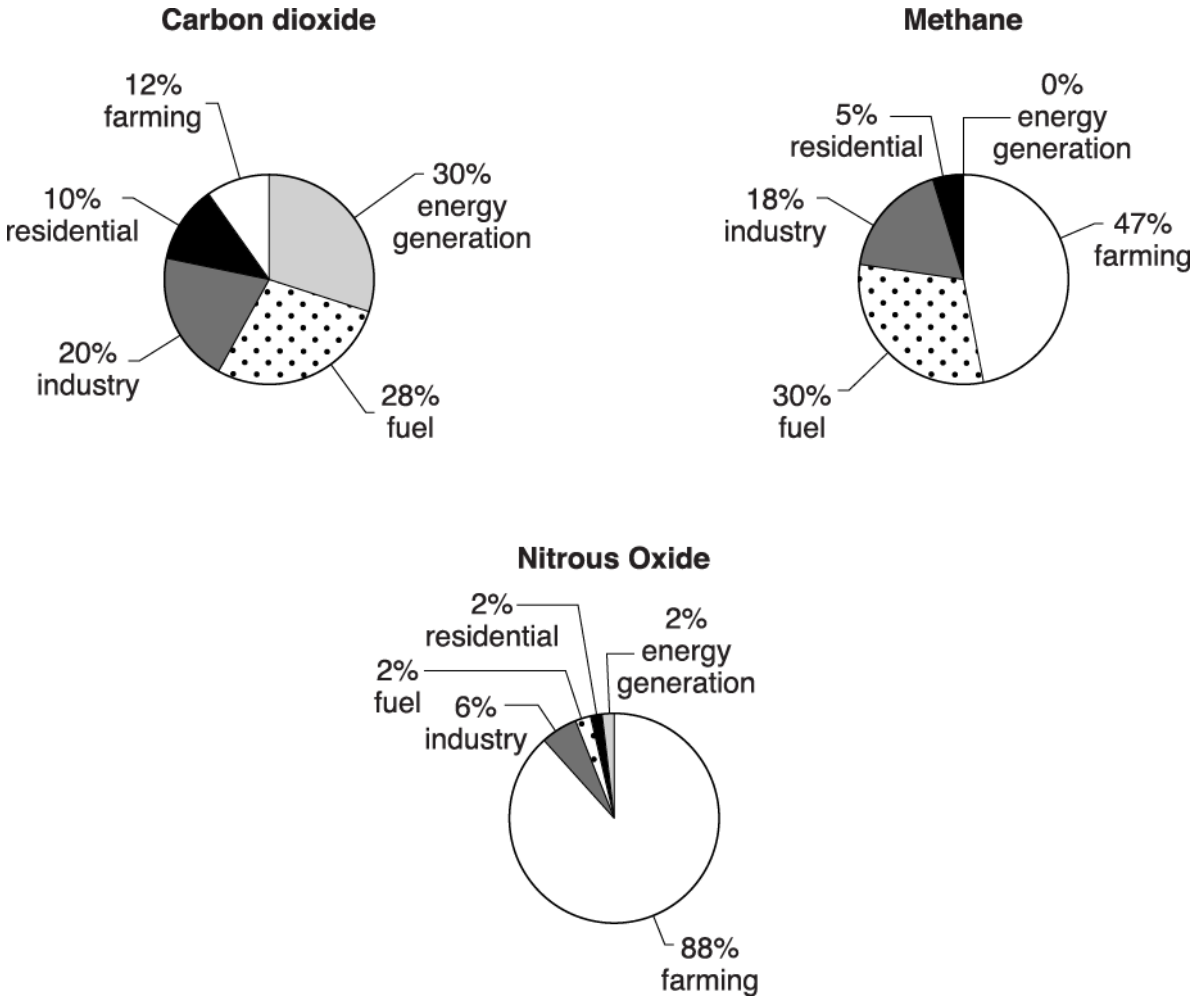
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Look at the pie charts about three greenhouse gases.

They show where these greenhouse gases come from.



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?

---

[2]

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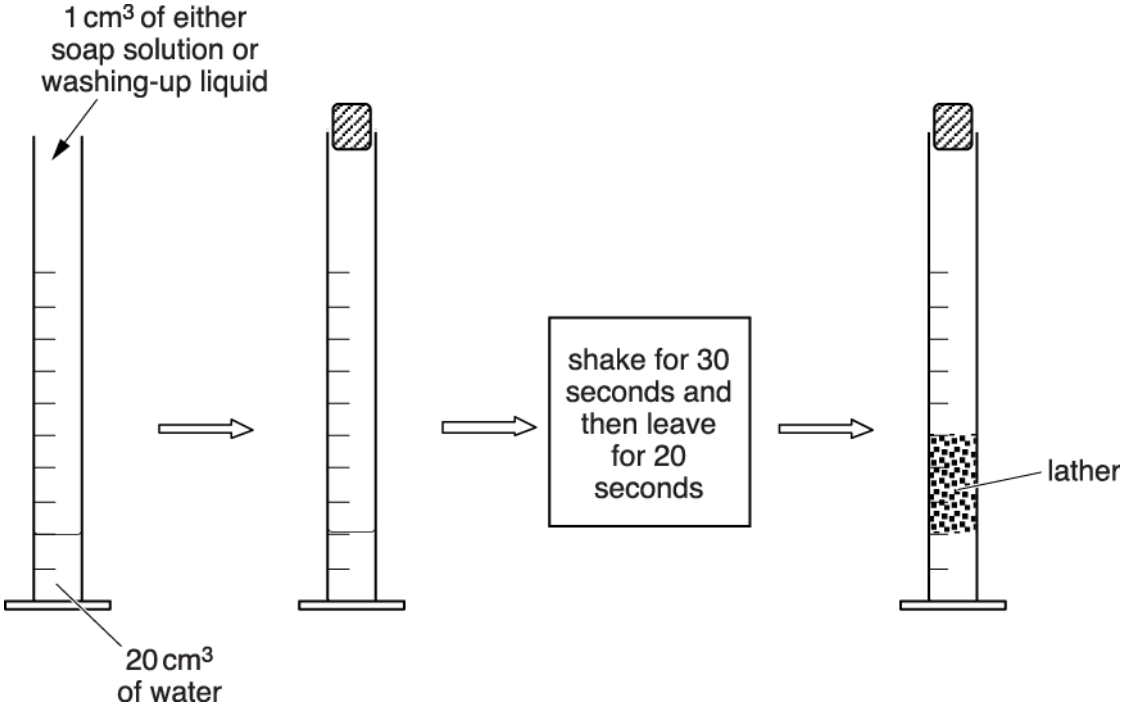
9 Magda and Sam investigate soap solution and washing-up liquid.

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
water with only permanent hardness	5	60
water with only temporary hardness	10	60
salt water	25	60

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Before she did the experiment, Magda predicted that 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.

---

[6]

10 Thirty years ago CFCs were used as refrigerants and aerosol propellants.

Nowadays the use of CFCs in the United Kingdom has been banned.

Write about some of the properties of CFCs that made them suitable as aerosol propellants.

Explain why the use of CFCs has now been banned in the United Kingdom.



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

[6]

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11 Farmers use fertilisers to improve crop yield.

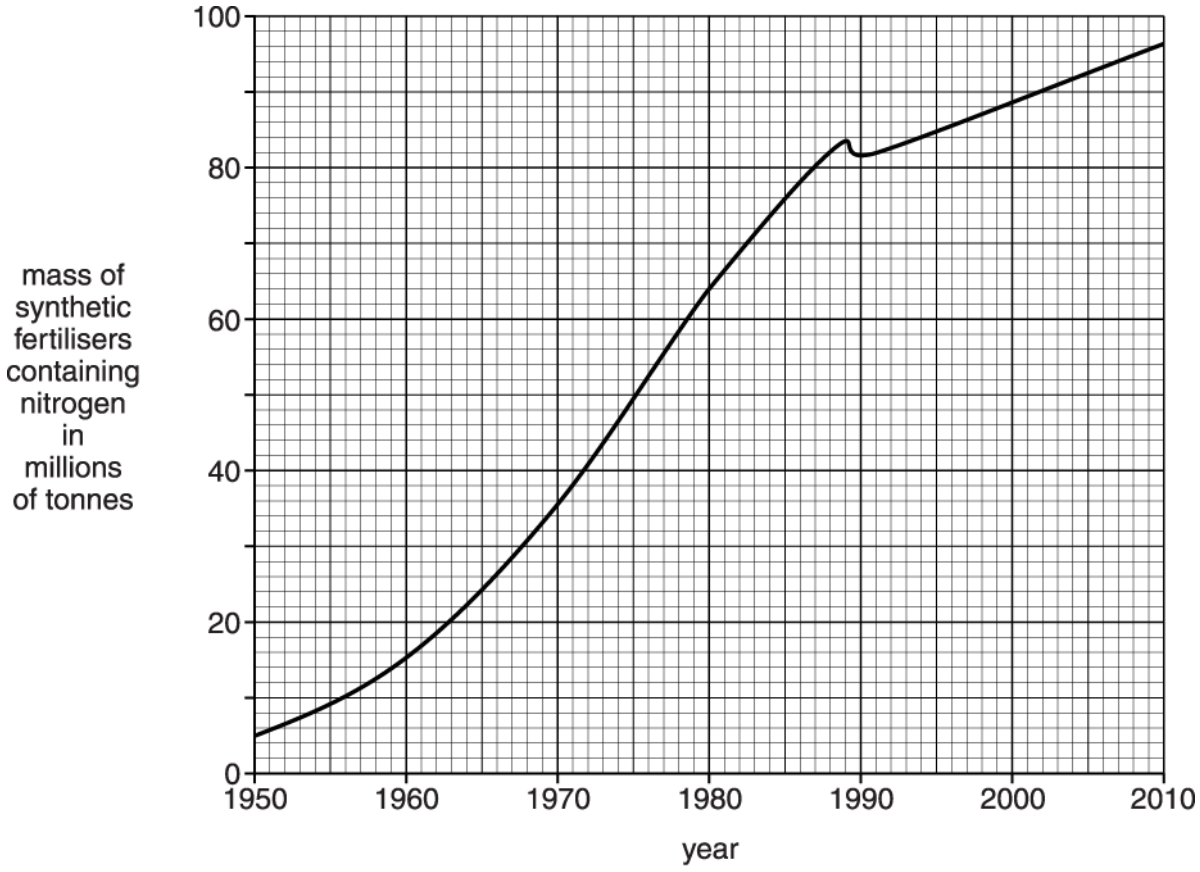
Fertilisers contain one or more of the three essential elements.

These essential elements are nitrogen, phosphorus and potassium.

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

Look at **Graph 1**.

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



Graph 1

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

mass = _____ millions of tonnes

[1]

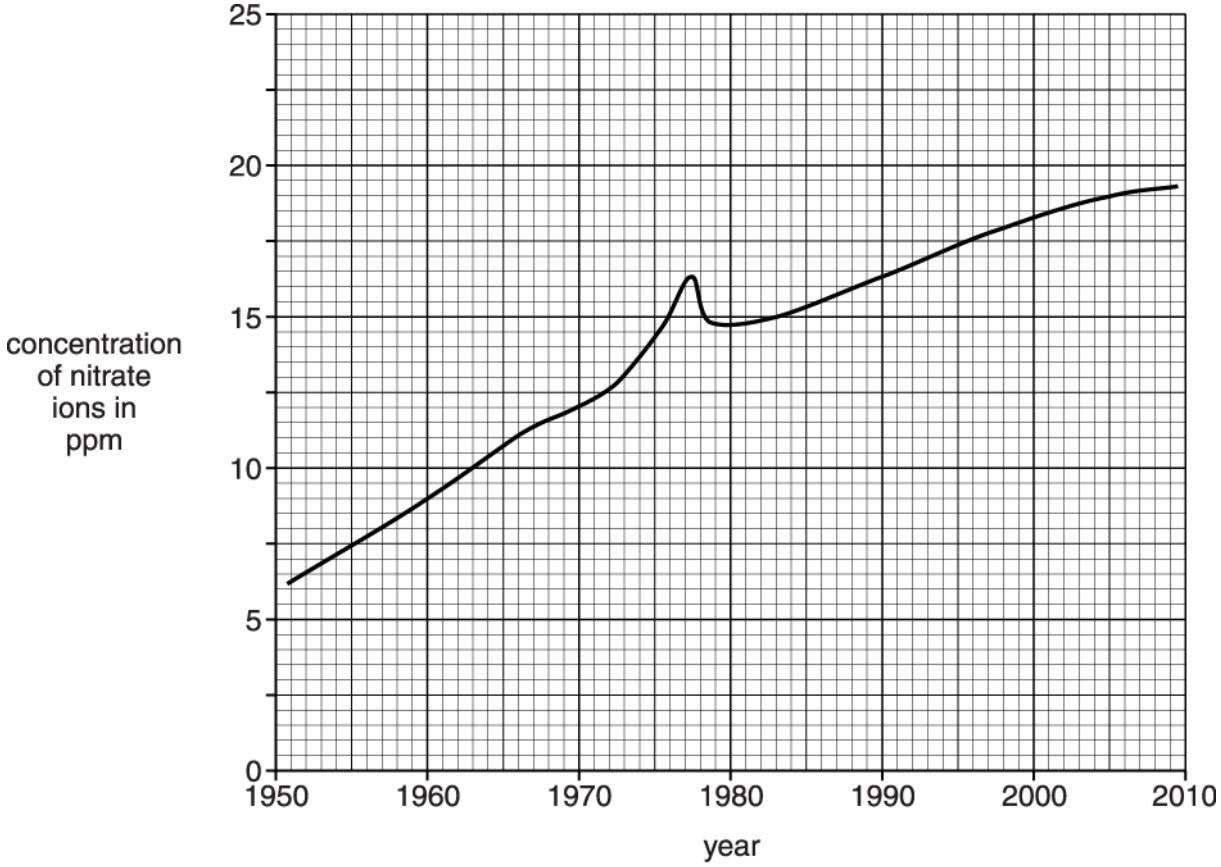
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(ii) Look at **Graph 2**.

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



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?

---

[1]

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12(a) 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	26000	66	61
B	963000	128000	4
C	62000	1400	34
D	67000	740	34
E	330000	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**.

mass of pesticides = _____ kg

[1]

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

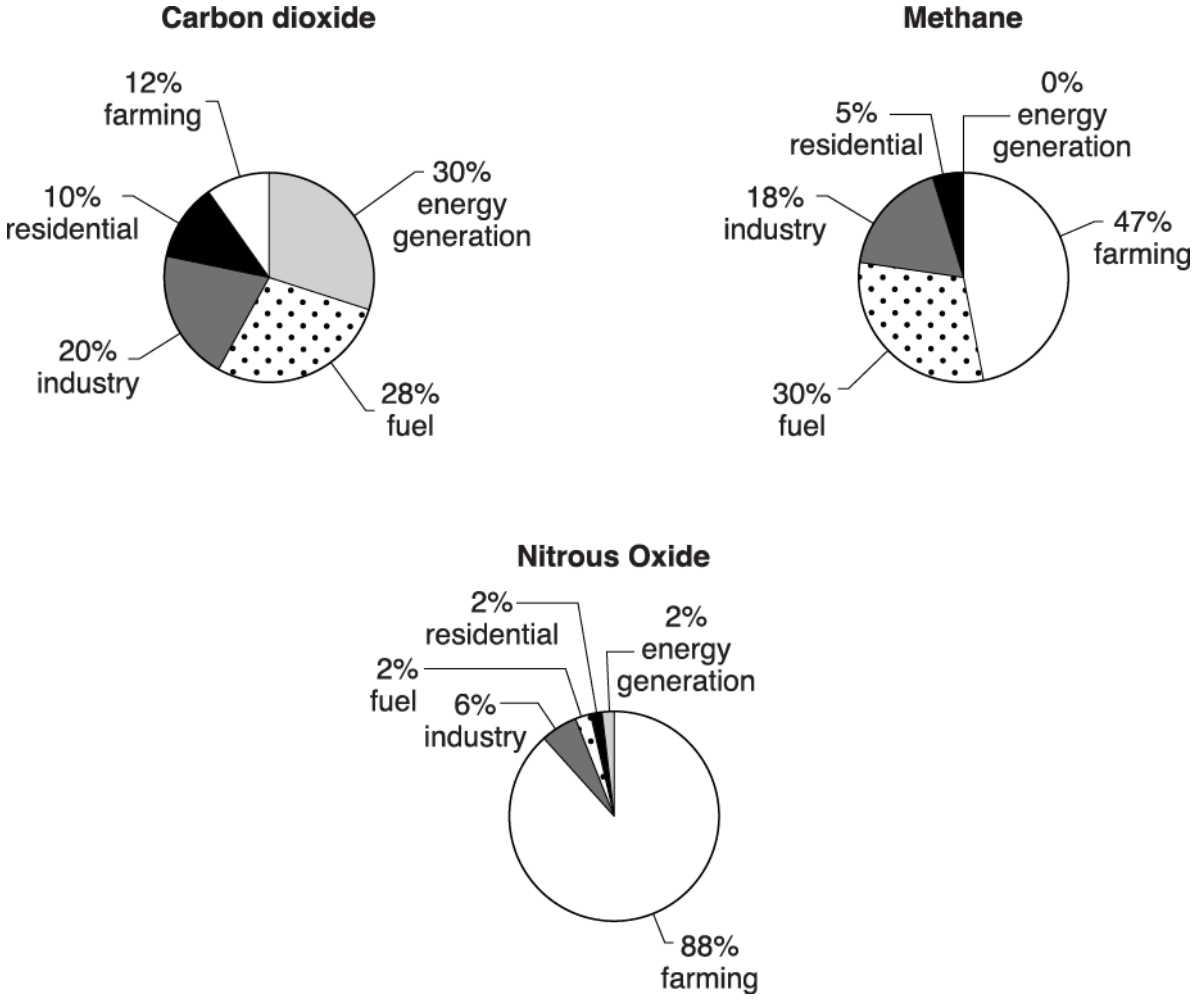
Suggest why. Use information from the table.

[2]

(b) 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.



(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.

-- [3]

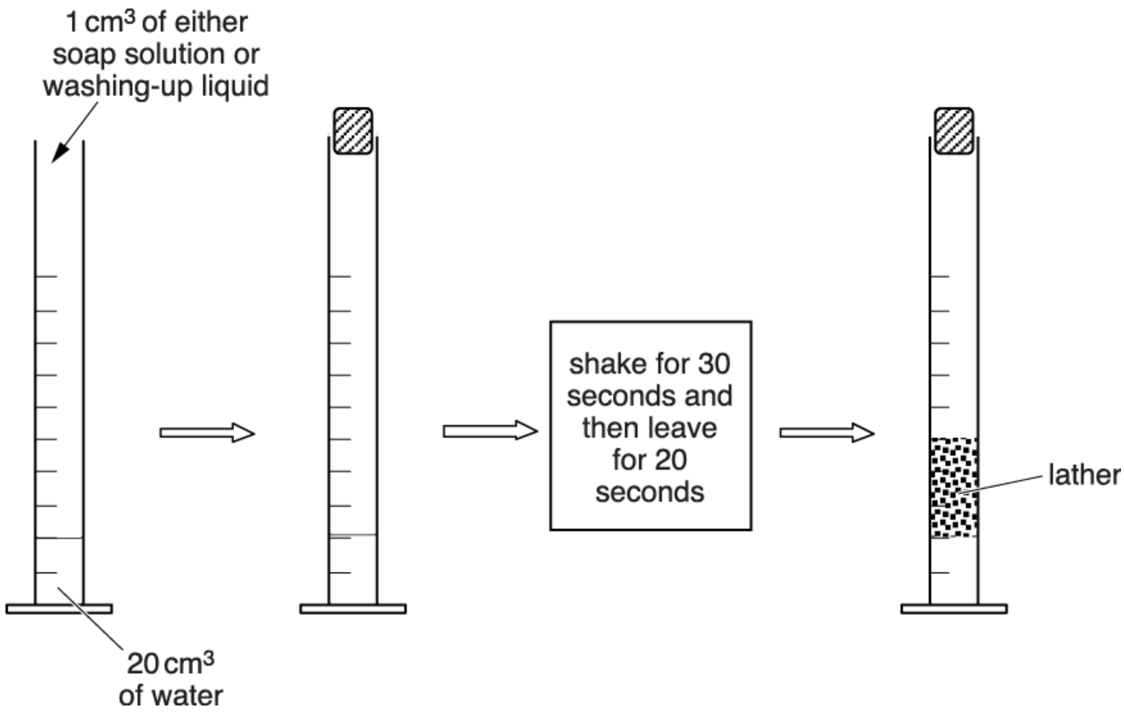
13 Magda and Sam investigate soap solution and washing-up liquid.

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.



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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.

---

[2]

14(a) The compound $C_2F_2C?_4$ 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.

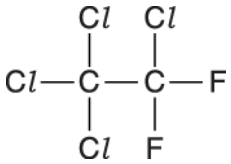
Reaction **1**	$C_2F_2C?_4 \rightarrow C_2F_2C?_3 + C?$
Reaction **2**	$C? + O_3 \rightarrow C?O + O_2$
Reaction **3**	$C?O + O \rightarrow C? + O_2$
Reaction **4**	$O_3 \rightarrow O_2 + O$
Reaction **5**	$O + O_2 \rightarrow O_3$

Ozone absorbs harmful ultraviolet radiation.

Which reaction happens when ozone absorbs ultraviolet radiation?

---------- [1]

(b) Look at the displayed formula for $C_2F_2C?_4$.



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

---------- [2]

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

Use reactions from the list to explain why.

---------- [2]

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(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.

---

[2]

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15 Air contains oxygen, nitrogen and carbon dioxide.

The percentage by volume of these gases in air hardly changes.

This is because of the balance between the three processes, combustion, respiration andphotosynthesis.

Write down the percentage by volume of oxygen and carbon dioxide in air.

Describe the effect of

- combustion
- respiration
- photosynthesis.

on these **two** percentages.

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

---

[6]

16 Air contains a mixture of gases.

The table shows the percentage by volume of different gases in air.

Gas	Percentage (%)
carbon dioxide	0.04
nitrogen	78
oxygen	21

The percentage by volume of these gases in air hardly changes because of the carbon cycle.

Explain why the percentage by volume of the gases in the table hardly changes.

Predict the effect that an increase in the world's population may have on these percentages.



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

[6]

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17 This question is about fuels.

Crude oil is a fossil fuel.

Crude oil is being used up faster than it is being made.

Write about the problems this will cause in the future.

---

[2]

18(a) This question is about car engines.

Car engines make carbon dioxide.

Look at the table.

The table shows the amount of carbon dioxide emitted by 5 cars, **A**, **B**, **C**, **D** and **E**.

Car	Carbon dioxide emissions in g/km
A	109.0
B	147.3
C	98.8
D	170.6
E	91.7

Henry wants to buy a car.

Henry finds out that car tax is not paid on cars with carbon dioxide emissions lower than **100 g/km**.

Henry would not have to pay car tax on some of these cars.

Which cars? Choose from **A**, **B**, **C**, **D** and **E**.

---

[1]

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(b) Carbon monoxide and oxides of nitrogen are also made in a car engine.

Write about how carbon monoxide is made in a car engine, and the problems caused by carbon monoxide and oxides of nitrogen.

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

[6]

19 Crude oil, coal and natural gas are fossil fuels.

These fuels are **non-renewable**.

Explain what is meant by non-renewable.

[2]

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20(a) This question is about air pollution.

Three atmospheric pollutants are:

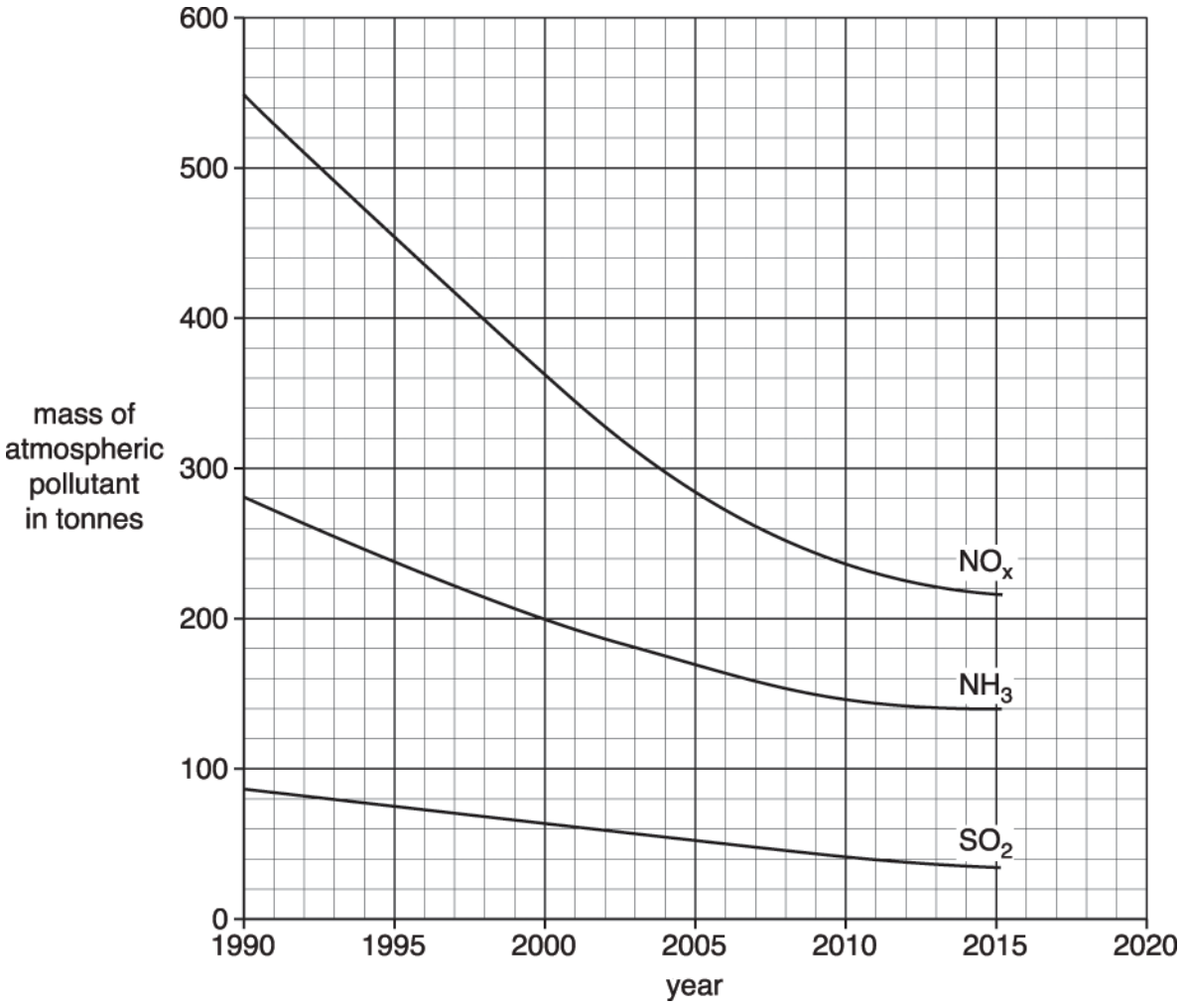
ammonia, NH_3

oxides of nitrogen, NO_x

sulfur dioxide, SO_2.

Look at the graph.

It shows how the masses of atmospheric pollutants have changed in a city since 1990.



(i) In what year was 200 tonnes of ammonia present in the atmosphere?

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_____

[1]

(ii) Describe the general trend in the amount of atmospheric pollutants present in the atmosphere since 1990.

Suggest a reason for this trend.

_____

_____

_____

_____ [2]

(b) The table shows information about atmospheric pollutants in some countries of the European Union.

Country	Population in millions	Mass of pollutant made in kilotonnes		
		NO_x	SO_2	NH_3
Estonia	1.3	38	83	10
Germany	80	1323	449	548
Poland	39	867	974	271
Slovakia	5.4	89	69	24
Sweden	9.6	161	34	52
United Kingdom	64	1106	406	284
Whole of European Union	508	9200	4600	3600

(i) Look at the table. Which of these countries makes the **greatest** mass of atmospheric pollutants?

Explain your answer.

_____

_____

_____

_____ [2]

(ii) In the European Union the order from **greatest** mass to **least** mass of pollutant made is

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greatest mass → least mass

NO_x

SO_2

NH_3

Is this trend shown by all the countries in the table?

Explain your answer. Use information from the table.

---

[2]

(iii) What percentage of the total mass of NH_3 made by the European Union comes from Sweden?

percentage = _____ %

[2]

(iv) The population of Sweden is 1.9% of the population of the European Union.

Compare this percentage with your answer in part (iii).

What conclusion can you make from these results?

---

[1]

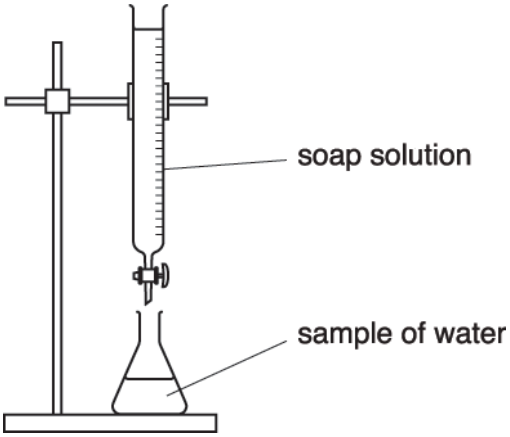
21(a) Kate is testing some samples of water with soap solution.

Look at the diagram. It shows the apparatus she uses.

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Kate adds soap solution to each sample of water and shakes it.

She keeps adding soap solution until a lather remains.

Look at the table. It shows her results.

Sample		Volume of soap solution added in cm^3
distilled water		5.0
X	before boiling	15.0
	after boiling	5.0
Y	before boiling	20.0
	after boiling	20.0
Z	before boiling	14.0
	after boiling	10.0

Which sample of water is the **hardest before boiling**?

Explain your answer.

---

[2]

(b) Kate has used soap solution.

She could have used a soapless detergent such as washing-up liquid.

There is a difference in the way that hard water reacts with a soap and with soapless detergent.

What is the difference?

---

[1]

(c) Which sample contains **only permanent hardness**?

Explain your answer.

---

[2]

(d) Write down one way that **permanent** hardness can be removed from water.

---

[1]

22(a) This question is about air pollution.

Three atmospheric pollutants are ammonia, NH_3, oxides of nitrogen, NO_x, and sulfur dioxide, SO_2.

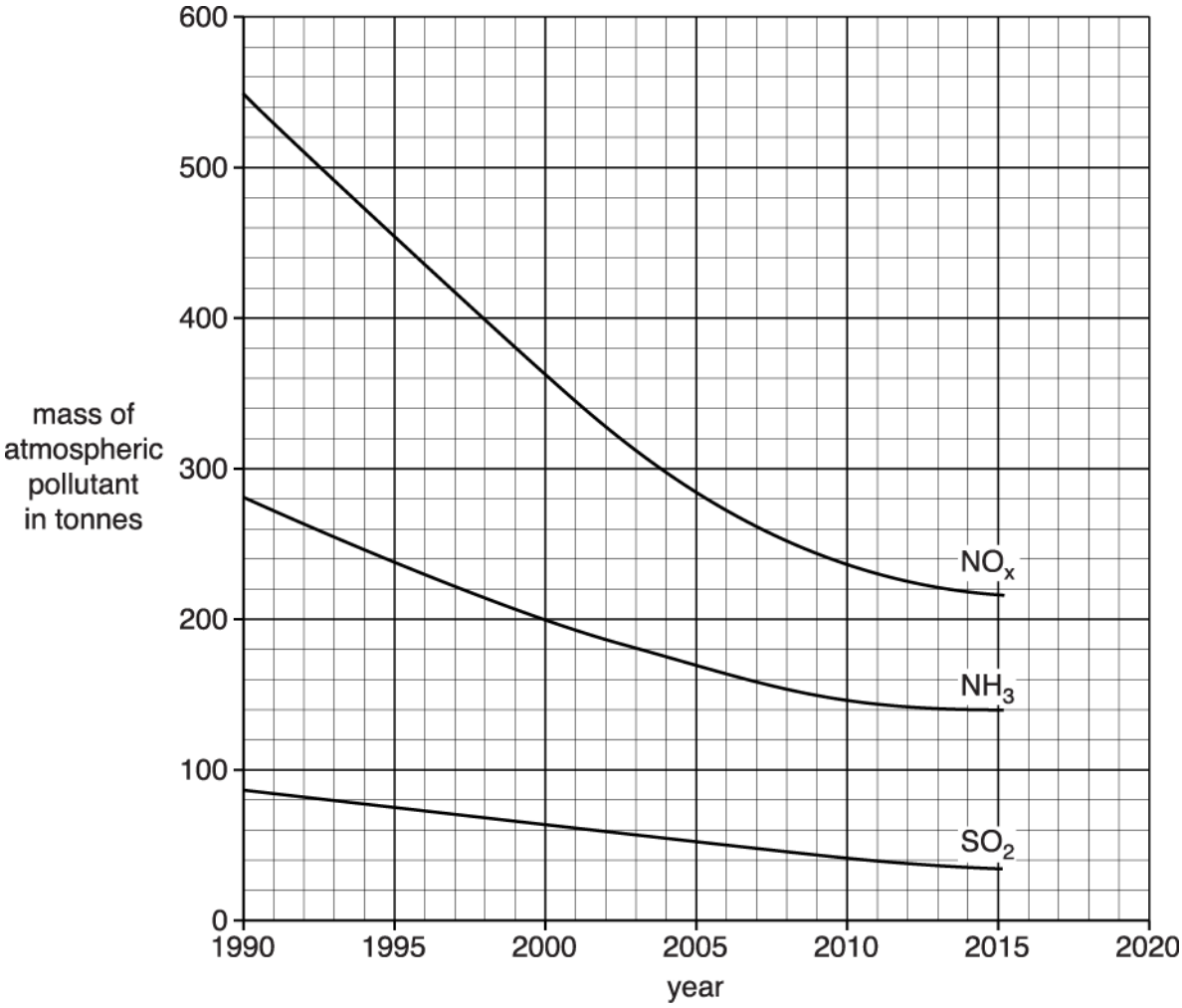
Look at the graph.

It shows how the masses of atmospheric pollutants have changed in a city since 1990.

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Which atmospheric pollutant showed the **greatest** change in mass between 1990 and 2000?

Explain your answer.

---

[2]

(b) The table shows information about atmospheric pollutants in some countries of the European Union.

Country	Population in millions	Mass of pollutant made in kilotonnes		
		NO_x	SO_2	NH_3
Estonia	1.3	38	83	10
Germany	80	1323	449	548
Poland	39	867	974	271
Slovakia	5.4	89	69	24
Sweden	9.6	161	34	52
United Kingdom	64	1106	406	284
Whole of European Union	508	9200	4600	3600

(i) What percentage of the total mass of NH_3 made by the European Union comes from Sweden?

percentage = _____ %

[2]

(ii) The population of Sweden is 1.9% of the population of the European Union.

Compare this percentage with your answer in part **(i)**.

What conclusion can you make from these results?

---**[1]**

(iii) Across the whole of the European Union an average of 9.1 kilotonnes of SO_2 is made for every million people.

In Poland how many kilotonnes of SO_2 are made for every million people?

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

answer = _____ kilotonnes

[2]

(iv) What conclusion can you make from your answer?

_____

_____ **[1]**

(v) Ann concludes that the amount of atmospheric pollutant made by a country is linked only to its population.

Nick thinks there are **other** factors involved as well.

Evaluate the evidence in the table in terms of both of these conclusions.

_____

_____

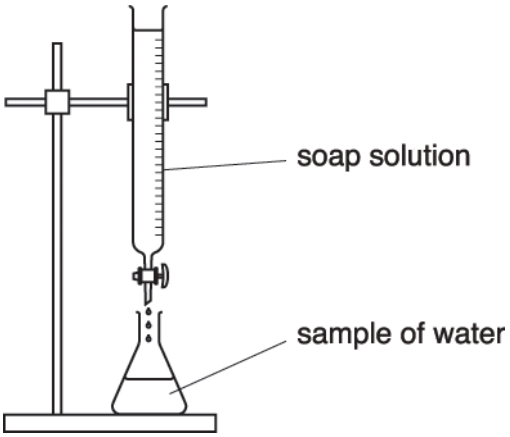
_____

_____

_____ **[2]**

23(a) Kate is testing some samples of water with soap solution.

Look at the diagram. It shows the apparatus she uses.



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Kate adds soap solution to each sample of water and shakes it.

She keeps adding soap solution until a lather remains.

Look at the table. It shows her results.

Sample		Volume of soap solution added in cm^3
distilled water		5.0
X	before boiling	15.0
	after boiling	5.0
Y	before boiling	20.0
	after boiling	20.0
Z	before boiling	14.0
	after boiling	10.0

There are two types of water hardness.

These are permanent hardness and temporary hardness.

What types of hardness are present in each water sample?

X _____

Y _____

Z _____

Explain your answers.

_____

_____

_____

_____

_____

_____

_____ [4]

(b) Washing soda (sodium carbonate) can be used to soften hard water.

Explain how washing soda softens hard water.

---

[2]

24(a) This question is about substances that are found in different types of water.

River water contains dissolved substances.

River water has to be purified before it can be drunk.

The water purification process has three stages.

These are

- filtration
- sedimentation
- chlorination.

Pollutants such as fertilisers are still in the water after this purification.

Explain why.

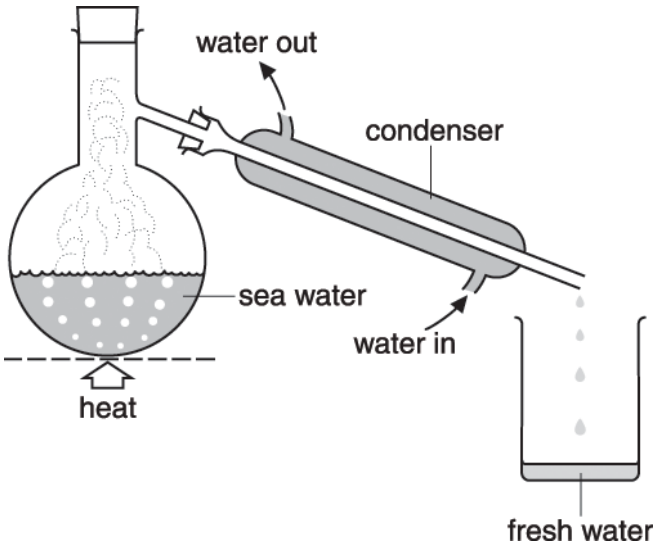
---

[1]

(b) Sea water can be made into drinking water.

One way this can be done is by **distillation**.

Look at the diagram. It shows the apparatus used to distil water in the laboratory.



Explain the **disadvantages** of using distillation to make **large amounts** of drinking water.

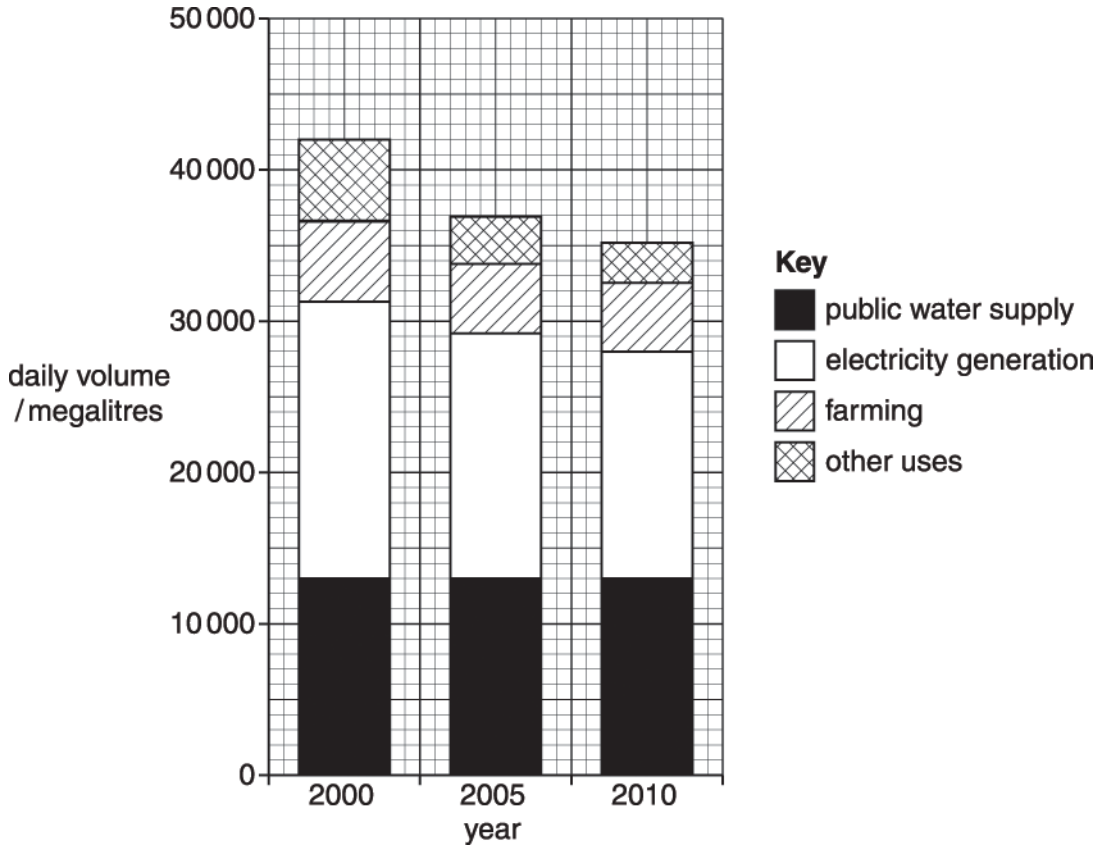
---

[2]

25(a) Water is a very important resource in the world.

Look at the bar chart.

It shows the uses of water in the United Kingdom in the years 2000, 2005 and 2010.



(i) The volume of water used each day decreased from the year 2000 to 2010.

Suggest why there has been a **decrease**.

Use information from the bar chart.

---

[1]

(ii) Look at the data for the year 2000.

The volume of water used for **public water supply** was 13 000 megalitres.

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Show that the percentage of the water used for the public water supply was 30.95%.

---[2]

(iii) The **volume** of water used for public water supply did not change between the years 2000 and 2010.

Describe how the **percentage** of water used for the public water supply changed between the years 2000 and 2010.

---[1]

(b) The volume of water used for the public water supply is affected by several factors.

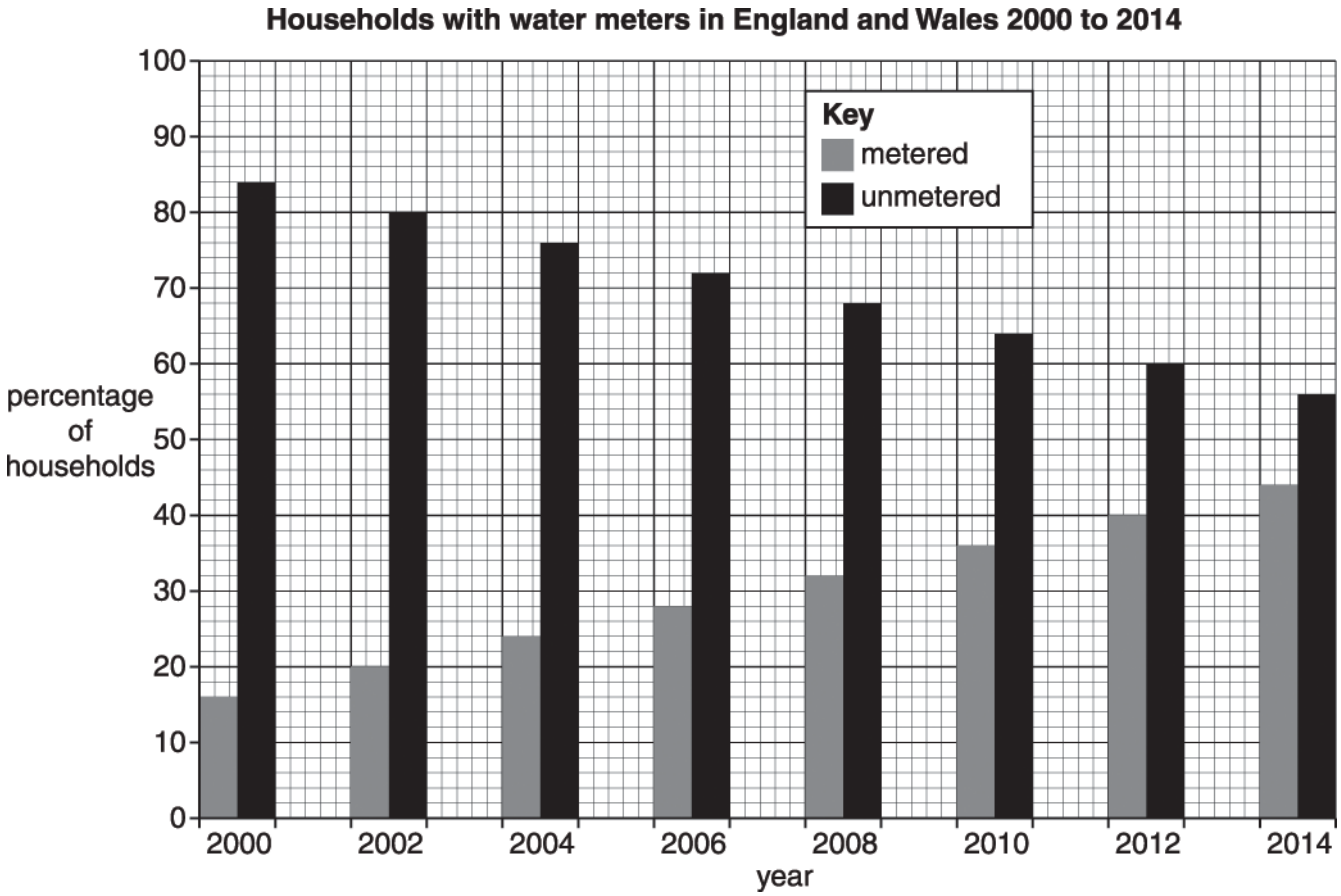
- Number of water meters fitted — people use much less water when they have a water meter fitted in their house
- Population
- Leakage of water from water pipes

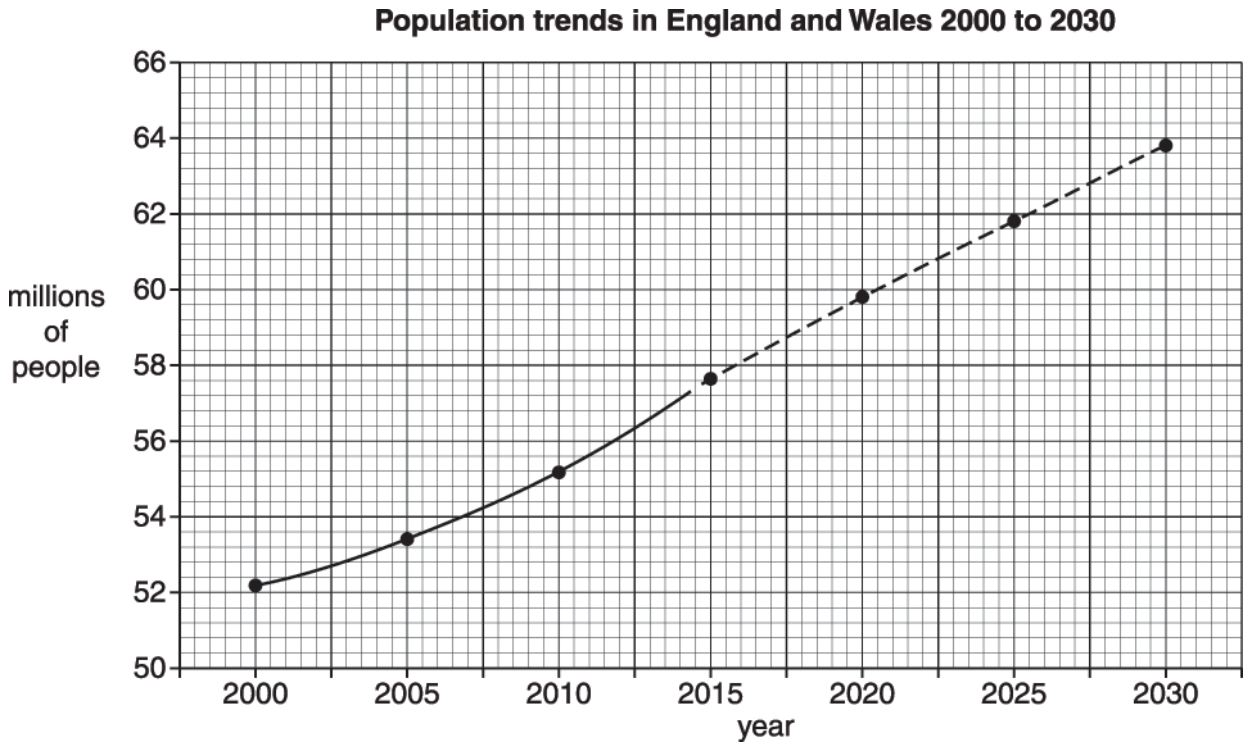
Look at the information about these three factors.

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Leakage of water between the years 2000 and 2014

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Year	Volume of water lost each day through leakage from water pipes in megalitres
2000	3800
2002	3900
2004	3700
2006	3800
2008	3700
2010	3900
2012	4000
2014	3700

Scientists want to predict the volume of water needed for public water supply in future years.

In 2014, the volume of water needed each day was 16 000 megalitres.

Suggest the future trend in the volume of water needed for public water supply.

Explain your answer.

Use information about the three factors in your explanation.

[3]

(c) Look at the table.

It shows the volume of water available from water resources each year.

It also shows the volume of water used each year.

Country	Population in millions	Water available each year in km^3	Water used each year in km^3
Albania	4	4	3
Bangladesh	161	38	27
China	1390	634	320
Niger	15	1.3	0.8
Saudi Arabia	30	27	18
Sudan	42	20	14
United Kingdom	54	60	30
United States	297	530	171

Some countries have lots of water available per million of its population.

Other countries have very little water available per million of its population.

(i) Which country uses the greatest **percentage** of the available water?

---

[1]

(ii) Write the name of the country most likely to have a shortage of water for its population.

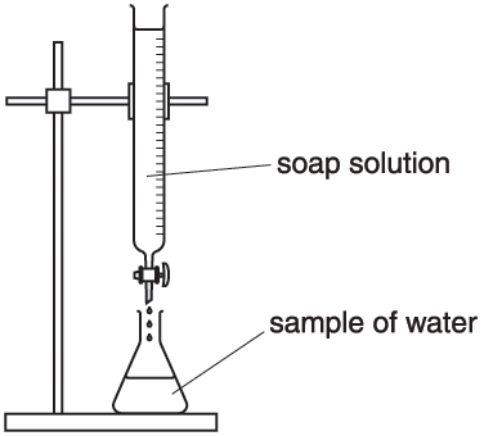
Explain your answer. Use data from the table.

---

[2]

26 Sunita and Carl are investigating 3 samples of water, **A**, **B** and **C**.

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



They add soap solution to samples of water and shake them.

They keep adding more soap solution until a lather remains.

Look at the table. It shows their results.

Sample		Volume of soap solution added in cm^3
distilled water		2.0
sample **A**	before boiling	10.0
	after boiling	10.0
sample **B**	before boiling	12.0
	after boiling	6.0
sample **C**	before boiling	7.0
	after boiling	2.0

Describe, with reasons, the types of hardness in water samples **A**, **B** and **C**.

Explain how washing soda (sodium carbonate) can soften hard water.

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

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---

[6]

27(a) Scientists are concerned about the pollution of both the air and water.

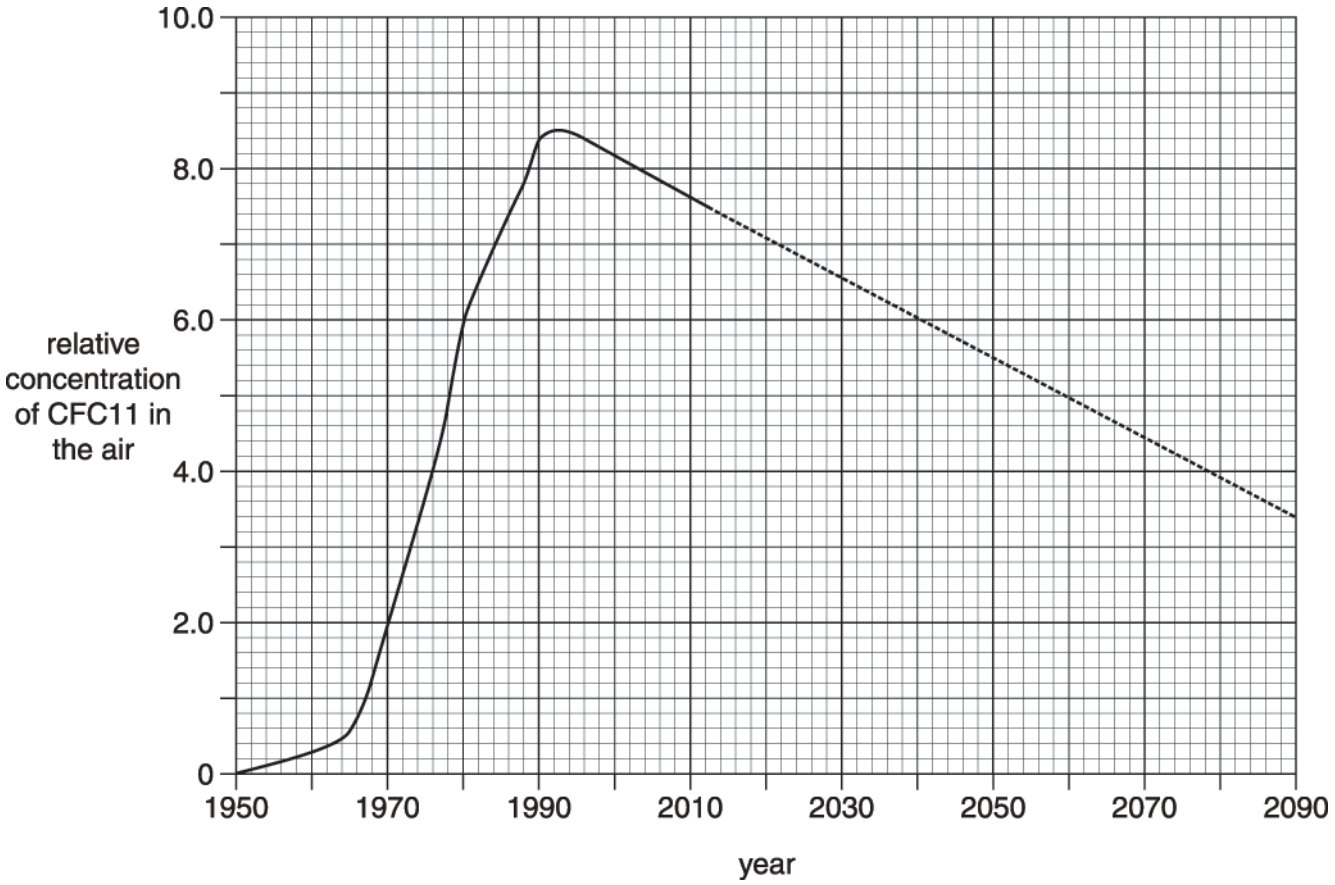
Chlorofluorocarbons, CFCs, are pollutants found in the air.

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.



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]

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(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.

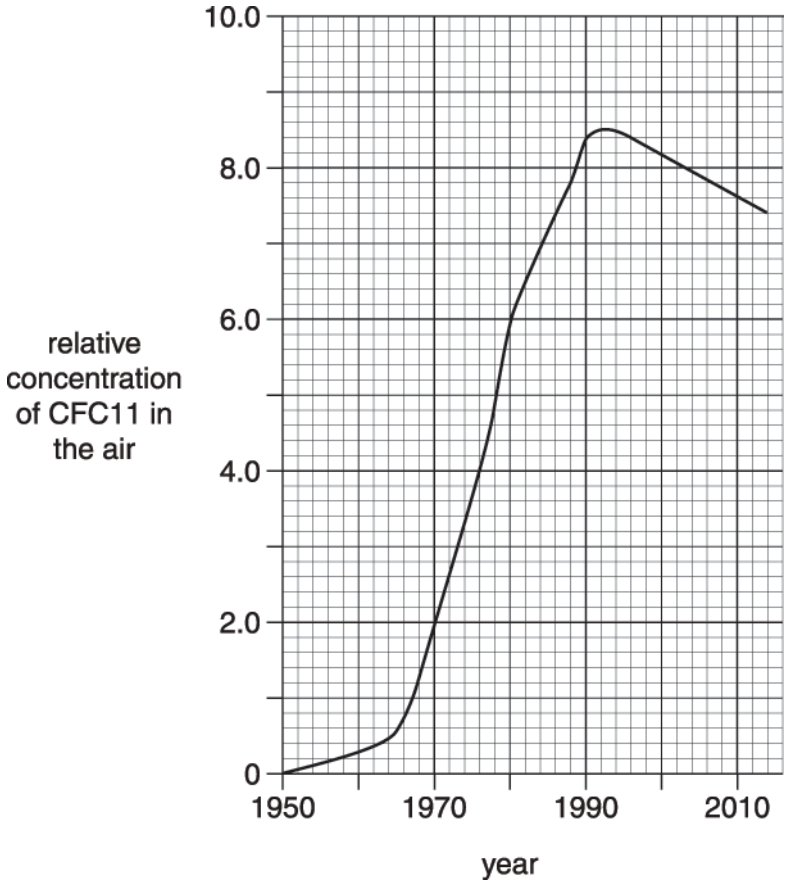
Look at this graph.

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

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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]

28(a) This question is about hard and soft water.

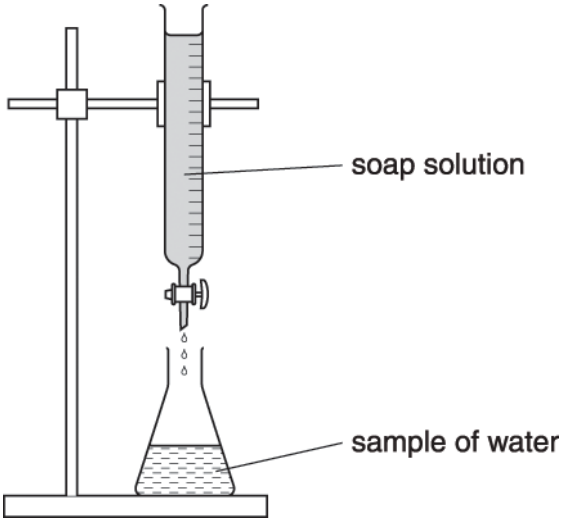
Jean investigates the hardness of three different samples of water.

Look at the diagram of the apparatus she uses.

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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.

---

[2]

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(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.

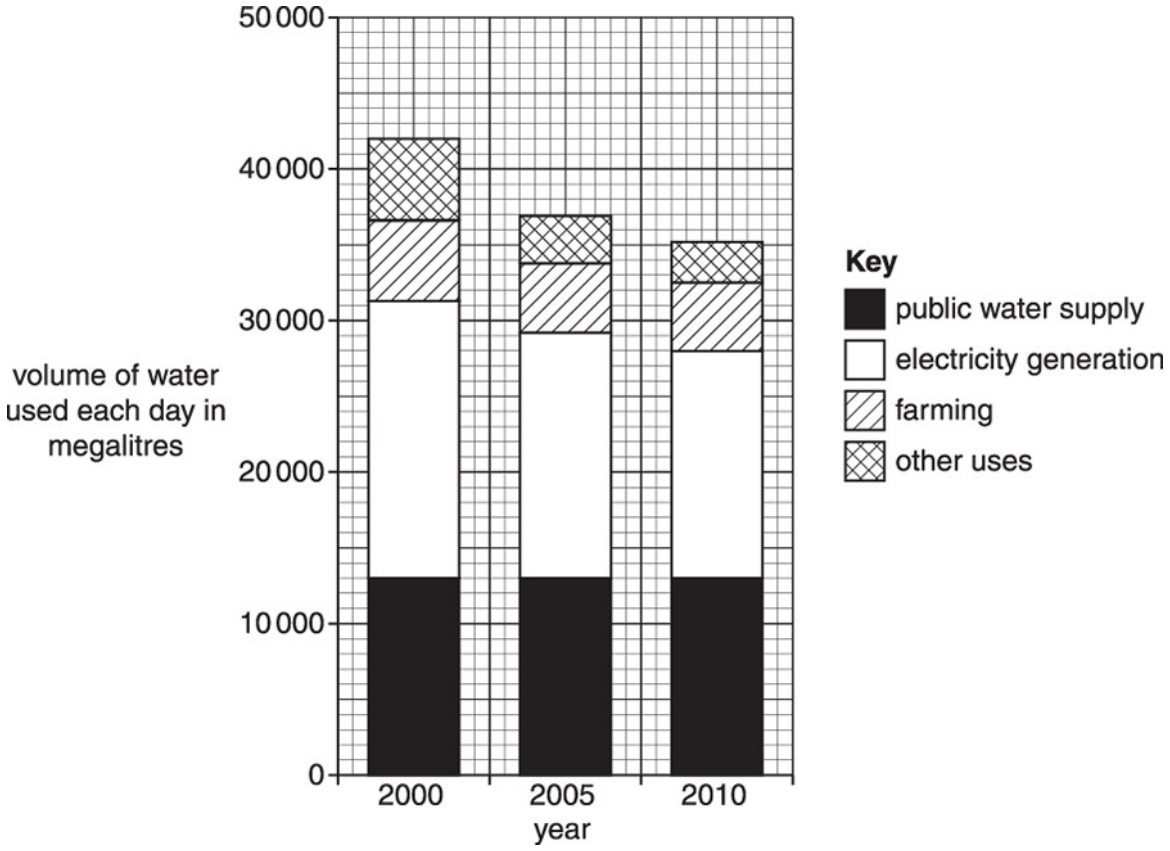
---

[1]

29(a) Water is a very important resource in the United Kingdom (UK).

Look at the bar chart.

It shows the uses of water in the UK for the years 2000, 2005 and 2010.



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(i) What was the **largest** use of water in the year **2000**?

[1]

(ii) The volume of water used for public water supply did not change between the years 2000 and 2010.

Describe **three** other patterns in water use between the years 2000 and 2010.

[3]

(iii) Look at the data for the year 2000.

In the year 2000 the volume of water used each day was 42 000 megalitres.

The volume of water used each day for **public water supply** was 13 000 megalitres.

Show that the percentage of the water used for the public water supply was 30.95%.

[2]

(iv) The **volume** of water used for public water supply did not change between the years 2000 and 2010.

Describe how the **percentage** of water used for the public water supply changed between the years 2000 and 2010.

[1]

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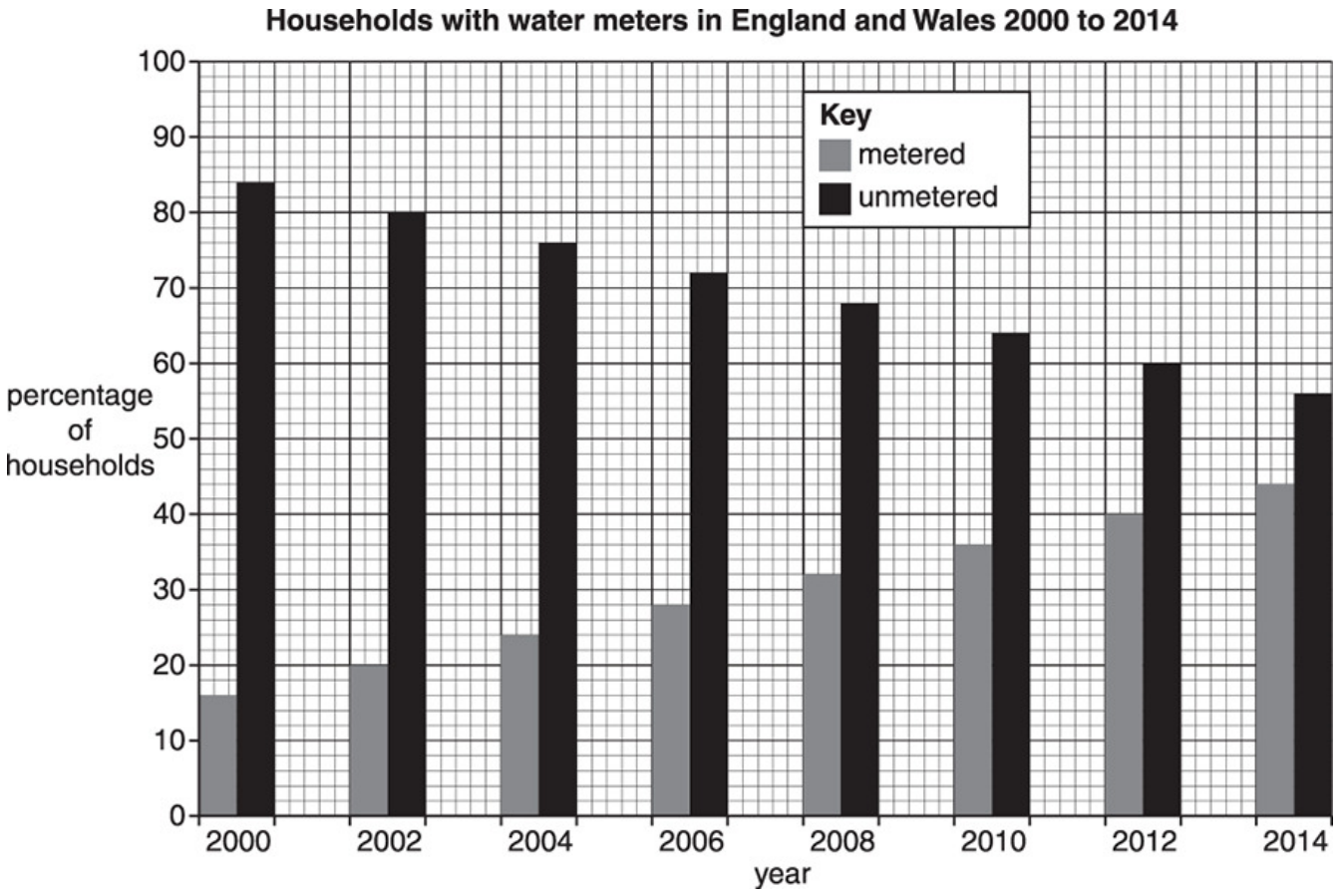
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(b) The volume of water used for public water supply is affected by several factors.

- Number of water meters fitted - people use much less water when they have a water meter fitted in their house

- Population

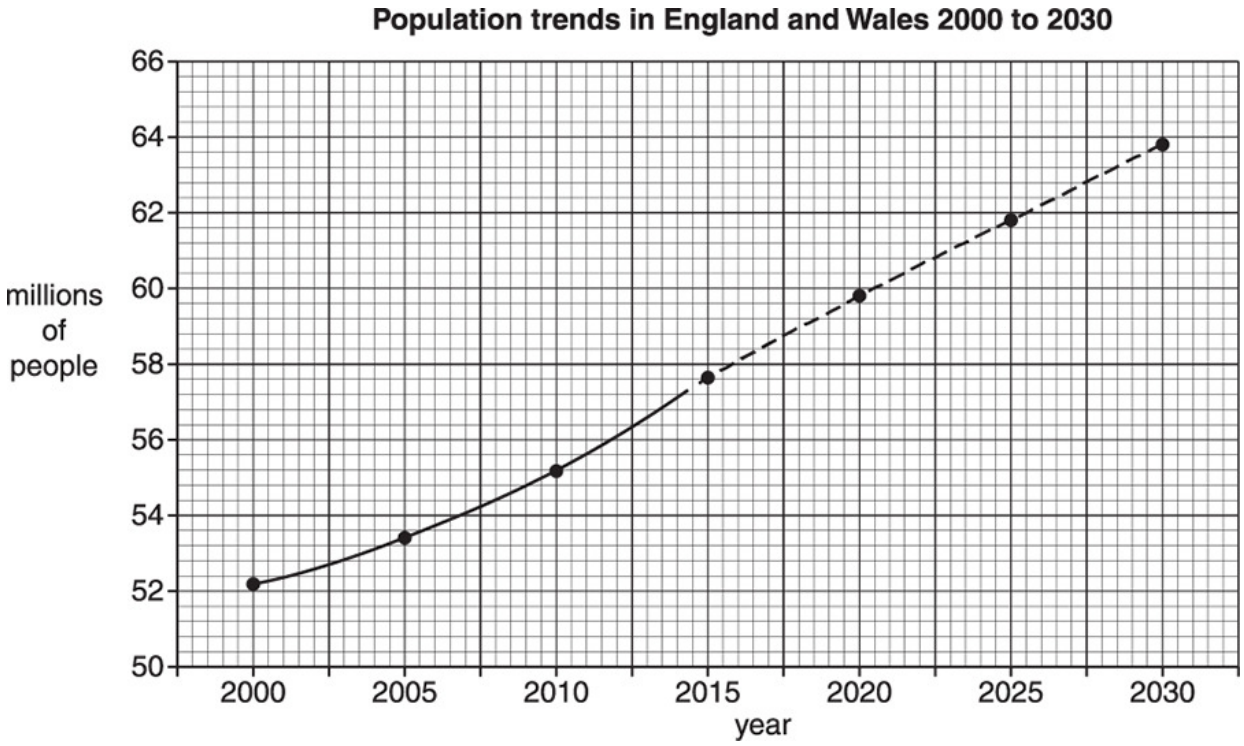
Look at the graphs about these two factors.



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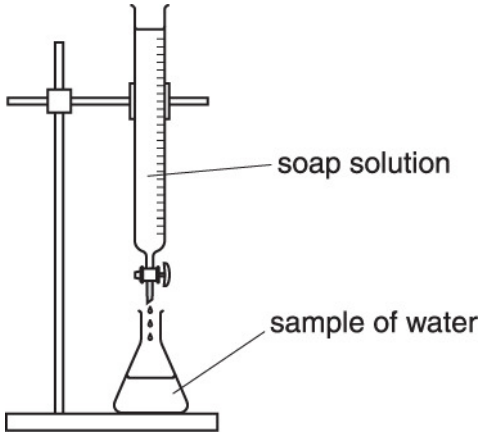
Scientists predict that the volume of water needed for public water supply may not change much in the future.

Explain how the data in the graphs support this prediction.

---[3]

30 Sunita and Carl are investigating 3 samples of water, **A**, **B** and **C**.

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



They add soap solution to samples of water and shake them.

They keep adding more soap solution until a lather remains.

Look at the table. It shows their results.

Sample		Volume of soap solution added in cm^3
distilled water		2.0
sample **A**	before boiling	10.0
	after boiling	10.0
sample **B**	before boiling	12.0
	after boiling	6.0
sample **C**	before boiling	7.0
	after boiling	2.0

Place the water samples, **A**, **B** and **C**, in order of their hardness (hardest first).

Write about the different types of hardness in each of the samples **A**, **B** and **C**.

Explain your answers.

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

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[6]

31 Small amounts of pollutants are sometimes found in tap water in the UK.

Write down the names of **two** of these pollutants.

1

2

[2]

32 A power station produces nitrogen dioxide gas.

The owners need to stop the nitrogen dioxide going into the atmosphere.

They can choose two methods:

- use limestone
- use sea water.

Look at the table. It shows some information about each method.

	Limestone	Sea water
Percentage of nitrogen dioxide removed	90%	99%
Waste made	carbon dioxide and a solid waste product	none – sea water is pumped back into the sea
Cost	expensive	cheap
Availability	mined from under the ground	must be pumped in from the coast
Mass needed to remove 1 g of nitrogen dioxide	1.2 g	3000 g

The power station is 100 kilometres from the coast.

The power station makes 9000 g of nitrogen dioxide.

Which method would be more suitable for removing nitrogen dioxide from the waste gases?

Explain your answer.

---[2]

33 Look at the table. It shows some properties of three metals.

	Density in g/cm^3	Relative electrical conductivity (0	Relative strength (0 = weak, 1000 = very strong)	Corrosion in moist air	Cost per tonne in £

		= low, 100 = high)			
Aluminium	2.7	40	300	does not corrode	770
Copper	8.9	64	400	corrodes slowly	5900
Iron	7.9	11	600	corrodes	200

Look at the picture. It shows overhead power cables used by electric trains.



Which metal would you choose to make the overhead power cables?

_____

Justify your answer.

Use the data in the table.

---

[2]

34(a) This question is about the gases in the air.

Clean air is a mixture of gases.

Complete the table to show the percentage of gases in clean air.

Gas	Percentage
_____	78%
_____	21%
carbon dioxide	_____

[2]

(b)

(i) Carbon monoxide and oxides of nitrogen are pollutants found in air.

Explain why it is important that atmospheric pollution is controlled.

---**[2]**

(ii) Catalytic converters are fitted to cars to help reduce air pollution from carbon monoxide, CO, and nitrogen monoxide, NO.

What happens in a catalytic converter?

Include a **balanced symbol** equation in your answer.

---**[3]**

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(c)



Air quality in the UK has improved over the last 60 years.

In December 1952, air pollution was so bad in London that sometimes people could not see their own feet.

Look at the graph.

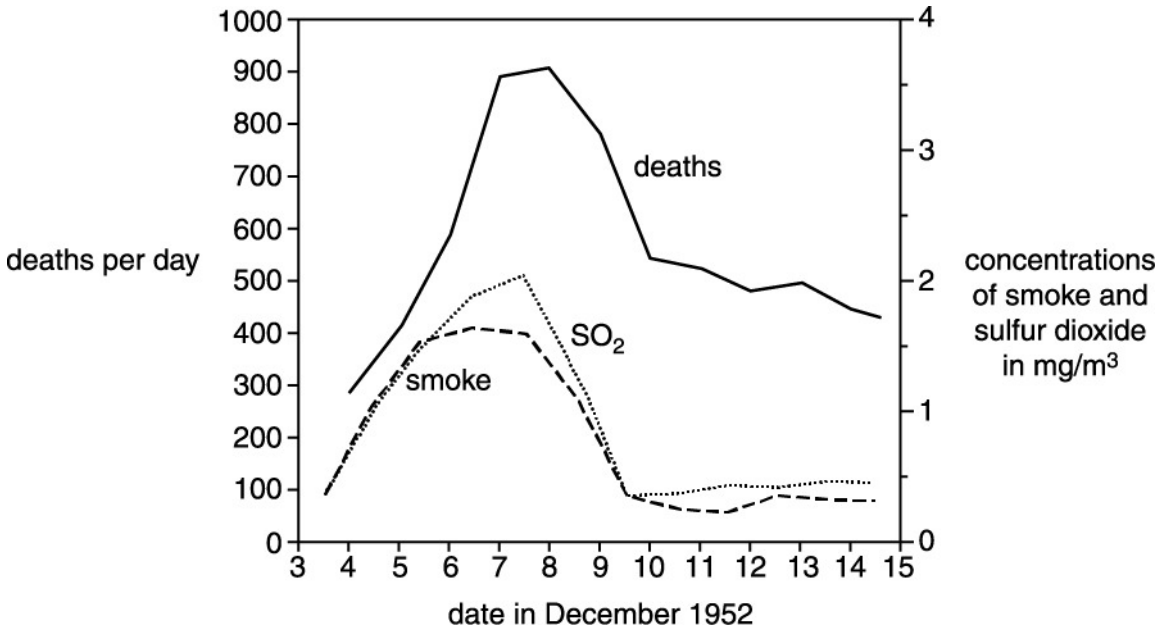
It shows the number of deaths each day in London, between 3 December and 15 December 1952.

It also shows the concentrations of smoke and sulfur dioxide.

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Describe the relationship between the number of deaths and the concentrations of smoke and sulfur dioxide.

---

[2]

35 This question is about building materials.

Limestone is a rock used for buildings.

(i) Write down the name of **another** rock used for buildings.

Choose from the list.

amalgam

brass

granite

solder

Answer _____

(ii) Limestone is dug out of the ground in a quarry.

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Removing limestone rock from a quarry causes environmental problems.

Write about **two** environmental problems caused by quarrying limestone.

---

[2]

36(a) Clean air is a mixture of gases.

The gases include nitrogen, oxygen and carbon dioxide.

The percentages of these gases do not vary much.

This is because of **photosynthesis** and **respiration**.

Complete the sentences about photosynthesis and respiration.

Choose words from the list.

carbon dioxide

decreases

increases

nitrogen

oxygen

(i) Photosynthesis increases the percentage of _____ in the air and decreases the percentage of _____ .

[1]

(ii) Respiration _____ the percentage of carbon dioxide in the air and _____ the percentage of oxygen.

[1]

(b) **Carbon monoxide** is a pollutant sometimes found in air.

Write about a **source** of carbon monoxide pollution and a **problem** caused by carbon monoxide.

---

[2]

(c)



Air quality in the UK has improved over the last 60 years.

In December 1952, air pollution was so bad in London that sometimes people could not see their own feet.

Look at the graph.

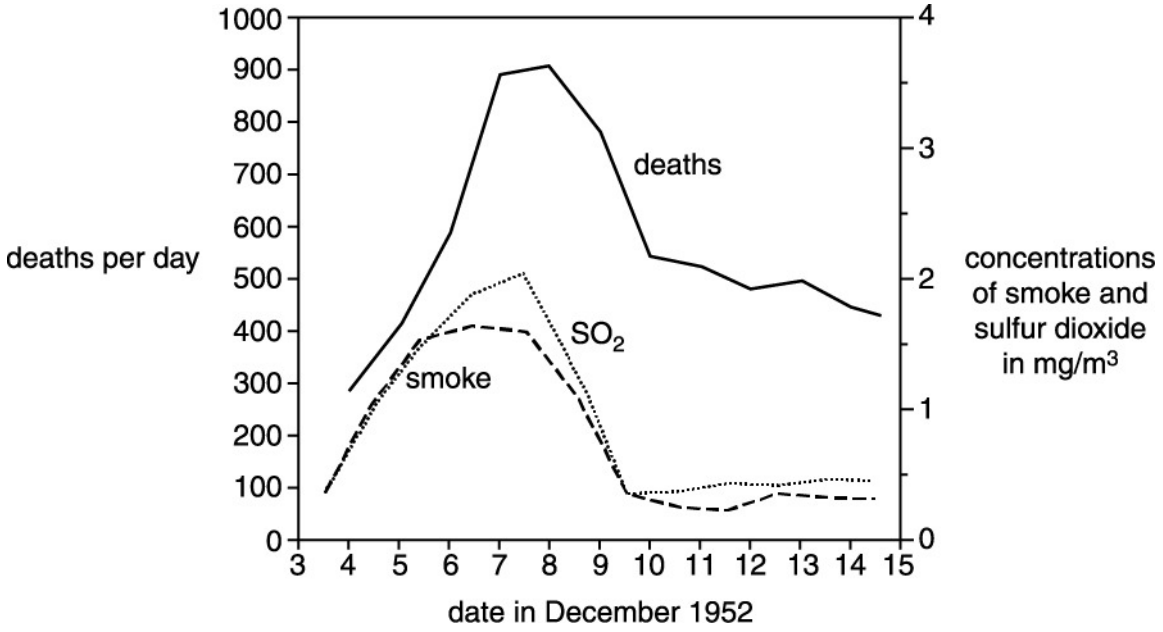
It shows the number of deaths each day in London, between 3 December and 15 December 1952.

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Describe the relationship between the number of deaths and the concentrations of smoke and sulfur dioxide.

---

[2]

(d) Catalytic converters are fitted to cars to help reduce air pollution.

Write down a pollutant removed by catalytic converters.

---

[1]

37 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.

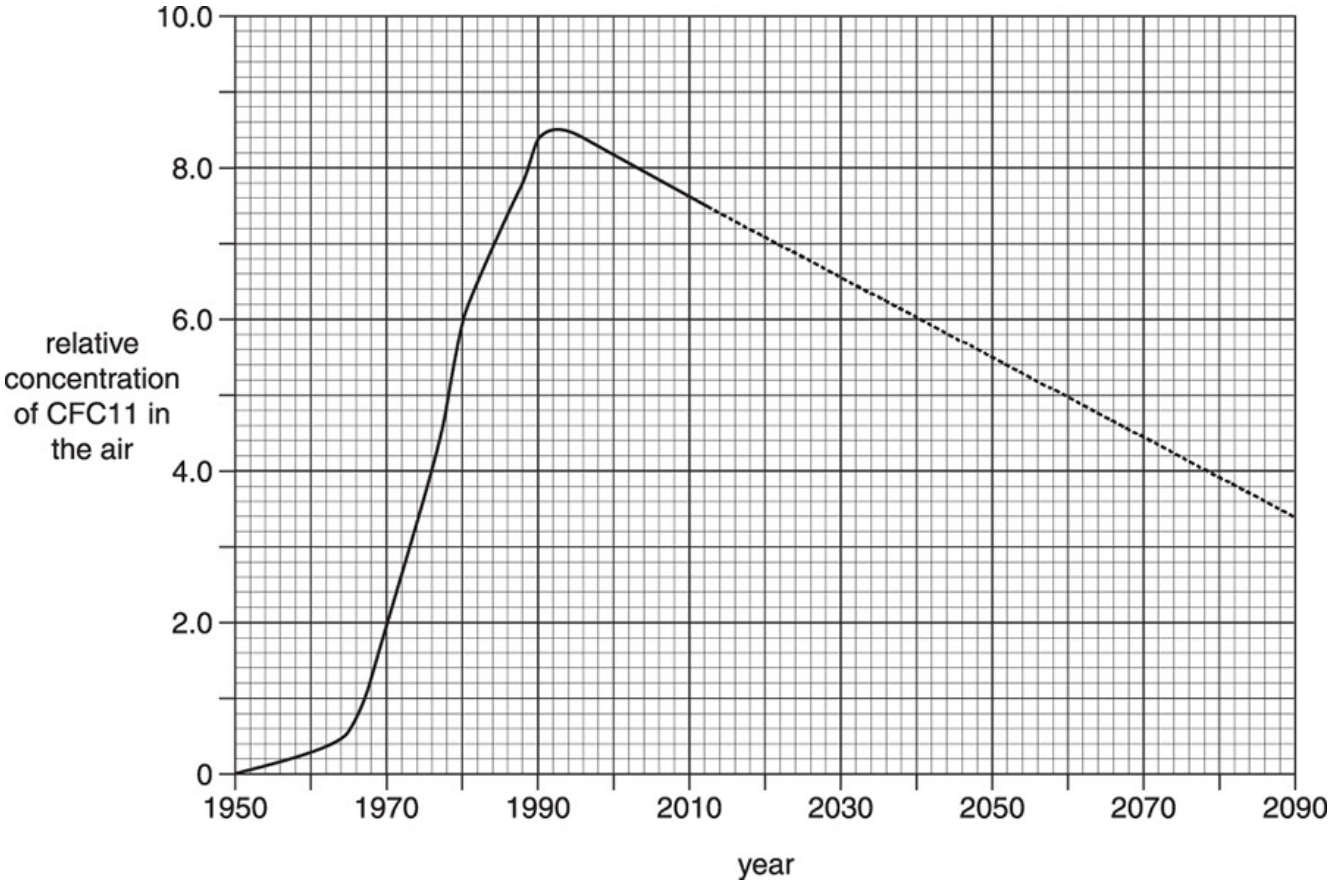
It shows how the concentration of CFC11 in the air has changed between 1950 and 2013.

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

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Describe how the concentration of CFC11 has changed from 1950 until 2013.

---

[2]

38(a) 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.

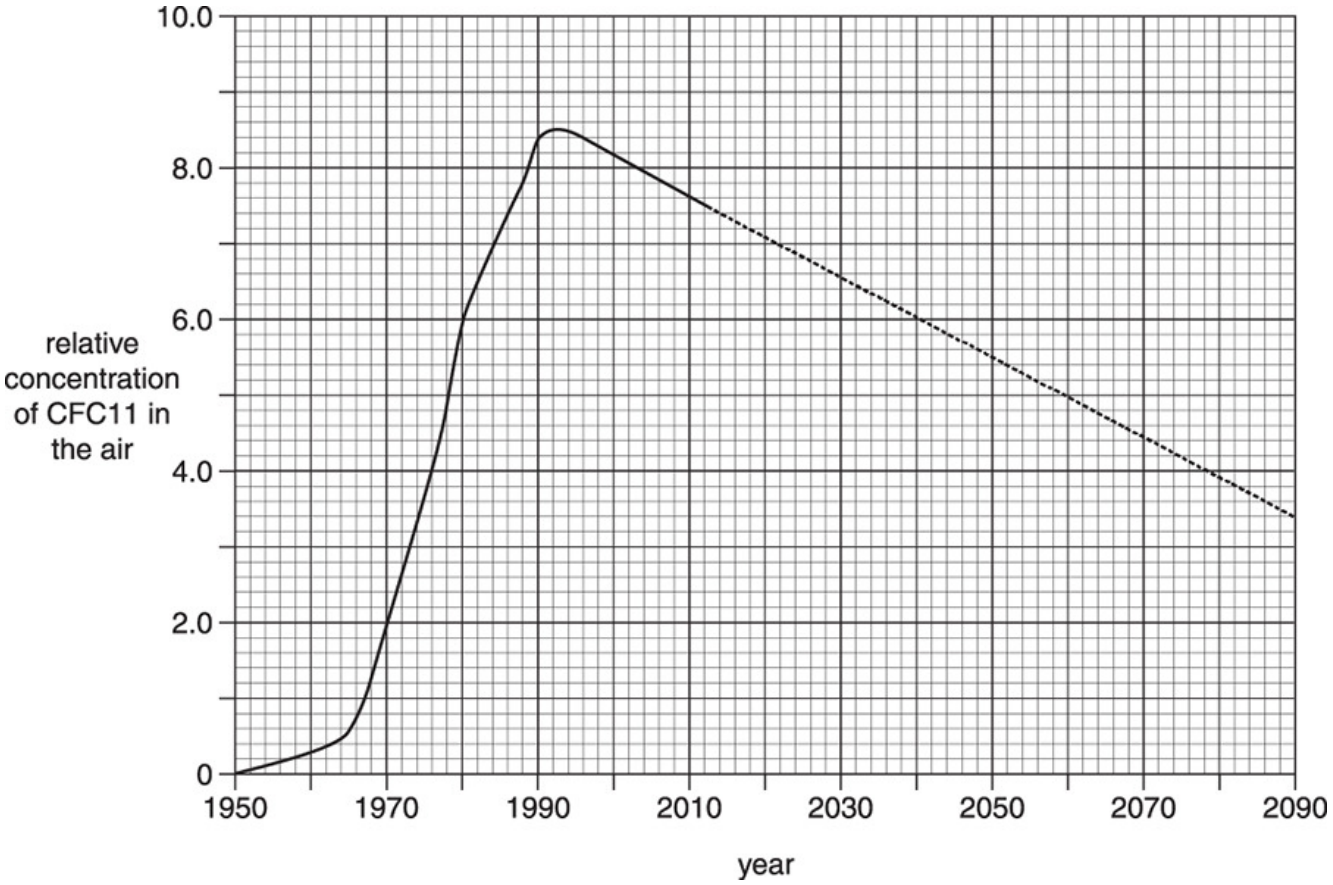
It shows how the concentration of CFC11 in the air has changed between 1950 and 2013.

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

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Many countries signed an international agreement to ban the use of CFCs.

Use the graph to suggest in which year the ban first started.

Explain your answer.

---

[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) Look at the graph.

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

---

[2]

(d) CFC12 is another chlorofluorocarbon.

Look at the table.

It shows how the concentration of **CFC12** in the air has changed between 1950 and 1990.

Year	Relative concentration of CFC12 in the air
1950	0
1960	0.1
1970	1.2
1980	4.0
1990	4.3

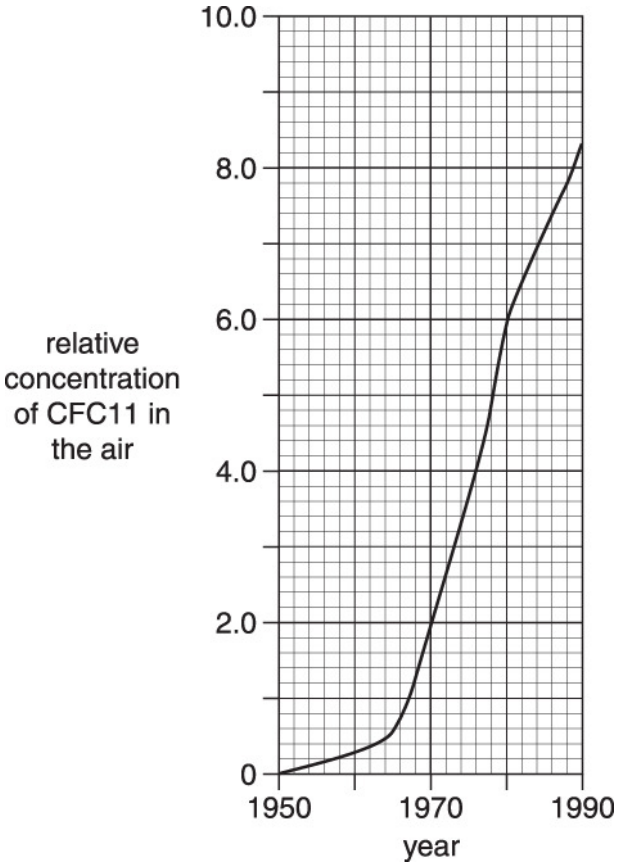
Look at this graph.

It shows how the concentration of **CFC11** in the air has changed between 1950 and 1990.

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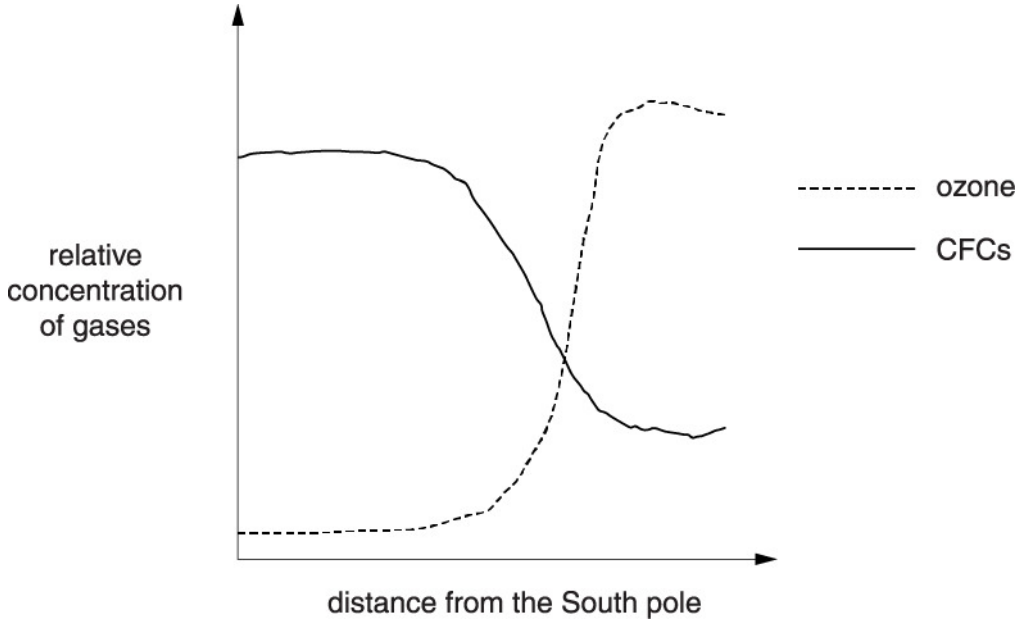
How does the concentration of CFC12 compare with that of CFC11?

[1]

(e) Scientists think that CFCs cause ozone depletion.

Look at the graph.

It shows how the ozone concentration and CFCs concentration change with increasing distance from the South Pole.



How does the information in the graph support the idea that CFCs cause ozone depletion?

---

[1]

39(a) Chlorofluorocarbons, CFCs, were used in the 1970s.

Scientists found evidence that CFCs cause holes in the ozone layer.

This allows more ultraviolet light to reach the surface of the Earth.

Describe some of the medical problems caused by the increasing levels of ultraviolet light.

---

[2]

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(b) The use of chlorofluorocarbons such as CCl_3F has now been banned in the UK.

Hydrofluorocarbons such as C_2HF_5 are now being used instead.

Explain which formula, **CCl_3F** or **C_2HF_5**, contains the **most** atoms.

---

[1]

40(a) This question is about hard and soft water.

Jean investigates which ions cause hardness in water.

She has four different water samples, **A**, **B**, **C** and **D**.

She shakes 10 cm^3 of each water sample with 0.5 cm^3 of soap solution.

Water sample	Ions present in water sample	Reaction with soap solution
A	Na^+ and Cl^-	no scum, lots of lather
B	Ca^{2+} and Cl^-	lots of scum, no lather
C	K^+ and NO_3^-	no scum, lots of lather
D	Mg^{2+} and NO_3^-	some scum, little lather

(i) Which sample of water is the **hardest**?

Choose from **A**, **B**, **C** or **D**.

---

[1]

(ii) The results show that Cl^- does **not** cause water to be hard.

Explain why.

---

[1]

(b) Jean investigates different types of water softeners.

Write about different ways hard water can be softened.

---

[2]

41 This question is about construction materials.

Cement is used in the construction of buildings.



Cement is made when **two** substances are heated together.

Which two?

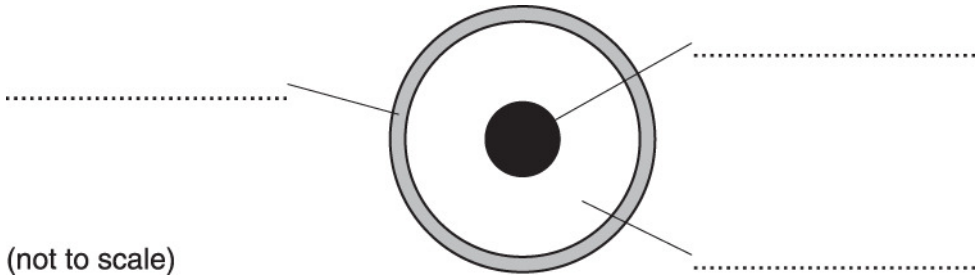
Put a tick (✓) in the correct box.

sand and water	☐
limestone and sand	☐
limestone and clay	☐
limestone and granite	☐
sand and clay	☐

[1]

42(a) This question is about the structure of the Earth.

Label the diagram of the Earth.



[2]

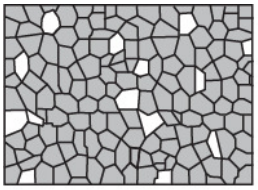
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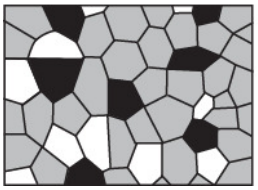
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(b) Igneous rocks are made when molten rock cools.

Look at the diagrams of two different types of igneous rock, **A** and **B**.



rock **A**



rock **B**

One rock was made when molten rock cooled **slowly**.

Which rock? _____

Explain your answer.

---

[1]

43(a) Coal is a fossil fuel. It is a non-renewable fuel.

What is meant by a **non-renewable** fuel?

---

[1]

(b) Sulfur dioxide causes acid rain.

Write about **two** environmental problems caused by acid rain.

---

[2]

44 Which type of water is **potable** water?

A Groundwater
B Seawater
C Tap water
D Waste water

Your answer [ ] [1]

45 How was the Earth's early atmosphere formed?

A Animals breathing
B Global warming
C Plants growing
D Volcanic activity

Your answer [ ] [1]

46 Which statement describes the **advantages** of instrumental methods of analysis?

A Instruments can analyse very small amounts and carry out the analyses slowly.
B Instruments are very accurate and use large amounts of substances.
C Instruments are very accurate and carry out the analyses slowly.
D Instruments are very accurate and can run all the time.

Your answer [ ] [1]

47(a) Some scientists believe that the increased burning of fossil fuels has contributed to global warming.

The scientists say that global warming is causing ice to melt, which results in sea levels rising.

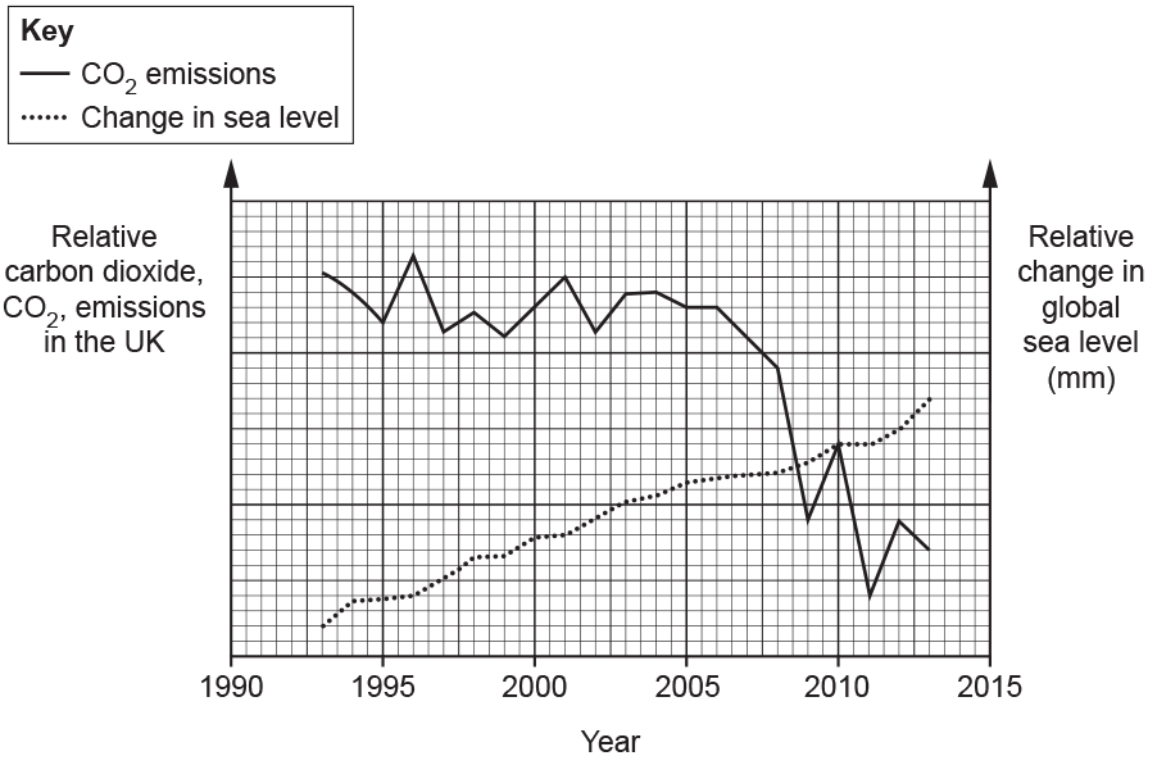
Other scientists believe that rises in global temperatures are just natural variations.

The graph shows the carbon dioxide, CO_2, emissions by fossil fuels in the UK and the changes in global sea levels between 1993 and 2013.

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Evaluate the information shown in the graph.

To what extent does the graph support a link between human activity and global warming?

[3]

(b) There are problems with using information about **CO_2 emissions by fossil fuels** to draw conclusions about the effect of carbon dioxide emissions on **global** sea levels.

Suggest what these problems are.

---

[2]

(c)

(i) Describe **one** effect on the Earth's climate of increased carbon dioxide levels, other than rising sea levels.

---

[1]

(ii) Suggest how we can lower carbon dioxide levels.

---

[1]

48 The table shows the composition of the Earth's early atmosphere compared with the atmosphere today.

	Nitrogen	Oxygen	Argon	Carbon dioxide
Percentage of gas in the early atmosphere	4	0.5	0.5	95
Percentage of gas in the atmosphere today	78	21	0.9	0.04

Which gas has **changed by the largest percentage** from the early atmosphere to the atmosphere today?

A Nitrogen
B Oxygen
C Argon
D Carbon dioxide

Your answer ☐ **[1]**

49 Which of these pairs of gases are **both** greenhouse gases?

A Nitrogen and methane
B Nitrogen and oxygen
C Water vapour and methane
D Water vapour and oxygen

Your answer ☐ **[1]**

50 Which statement about the greenhouse effect and greenhouse gases is correct?

A Greenhouse gases absorb all the infrared radiation that is emitted by the Earth's surface.
B The greenhouse effect is caused by the infrared radiation being absorbed and re-emitted by greenhouse gases.
C The lower the concentration of greenhouse gases in the Earth's atmosphere, the warmer the Earth becomes.
D Greenhouse gases are a large percentage of the Earth's current atmosphere.

Your answer ☐ **[1]**

51(a) Some scientists believe that the increased burning of fossil fuels has contributed to global warming.

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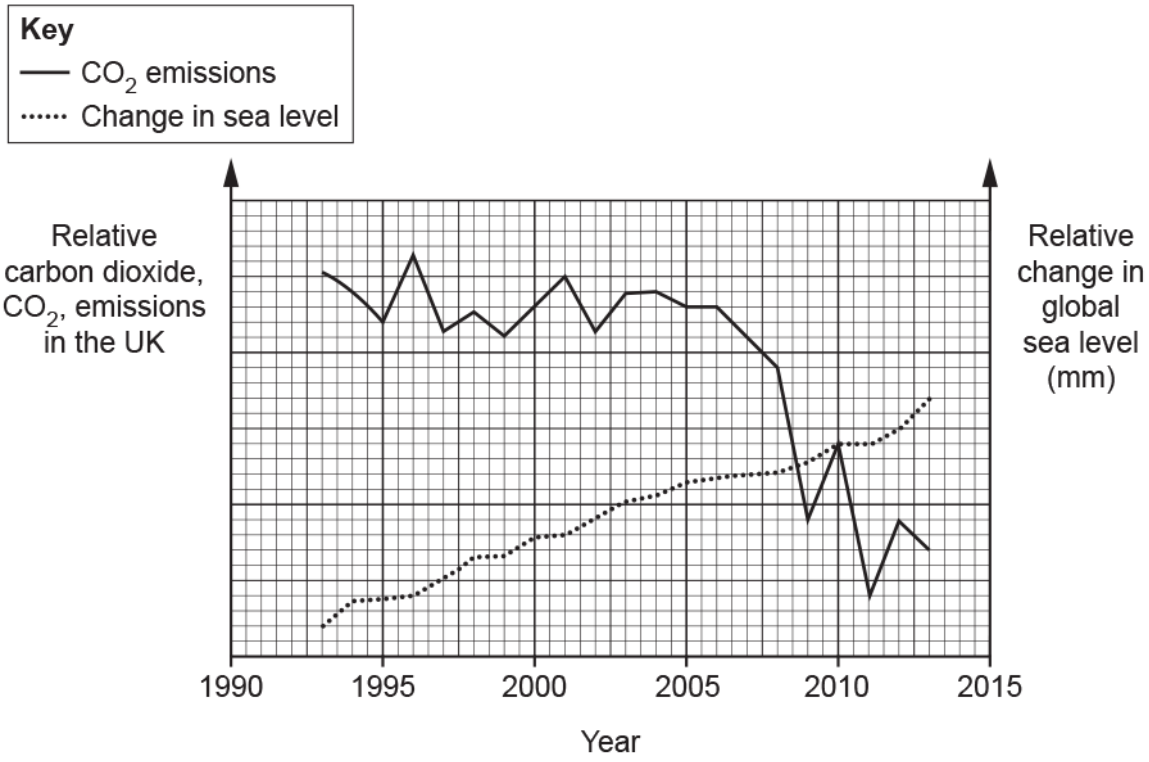
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The scientists say that global warming is causing ice to melt, which results in sea levels rising.

Other scientists believe that rises in global temperatures are just natural variations.

The graph shows the carbon dioxide, CO_2, emissions by fossil fuels in the UK and the changes in global sea levels between 1993 and 2013.



Evaluate the information shown in the graph.

To what extent does the graph support a link between human activity and global warming?

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[3]

(b) There are problems with using information about **CO_2 emissions by fossil fuels** to draw conclusions about the effect of carbon dioxide emissions on **global** sea levels.

Suggest what these problems are.

---

[2]

(c)

(i) Describe **one** effect on the Earth's climate of increased carbon dioxide levels, other than rising sea levels.

---

[1]

(ii) Suggest how we can lower carbon dioxide levels.

---

[1]

52(a) This question is about the Earth's atmosphere.

The Earth's early atmosphere contained mostly carbon dioxide gas.

The Earth's atmosphere today contains about 0.04% carbon dioxide.

Explain why the amount of carbon dioxide in the atmosphere today has decreased from the early atmosphere.

---

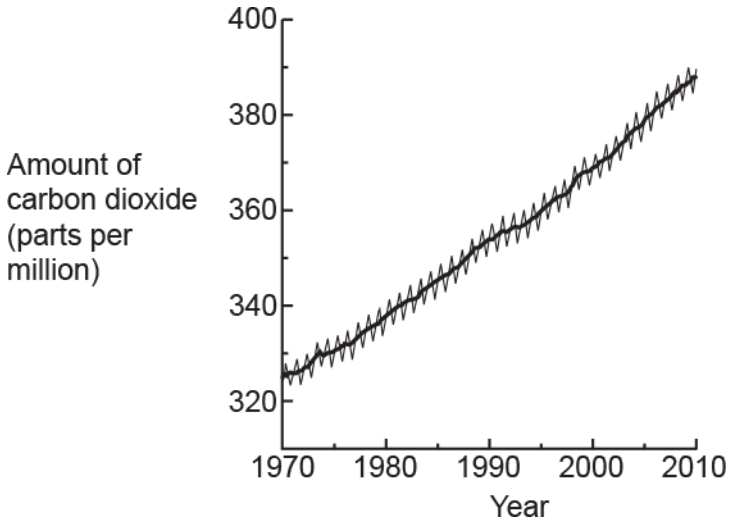
[1]

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(b) The graph shows the amount of carbon dioxide in the Earth's atmosphere from 1970 to 2010.



Describe the trend in the amount of carbon dioxide in the Earth's atmosphere from 1970 to 2010.

[1]

(c) Many scientists believe that increasing amounts of carbon dioxide in the Earth's atmosphere are causing global warming.

(i) Write down **one** way that carbon dioxide is **released** into the atmosphere.

[1]

(ii) Write down **one** way to **reduce** the amount of carbon dioxide that is released into the atmosphere.

[1]

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(d) Sulfur dioxide is a pollutant found in many large cities.

Sulfur dioxide is an **acidic** gas.

(i) Suggest a value for the pH of sulfur dioxide.

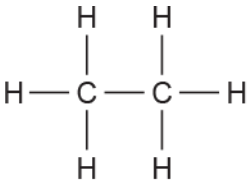
[1]

(ii) Describe **one** problem caused by sulfur dioxide.

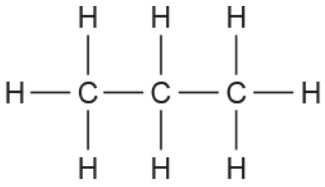
[1]

53 This question is about compounds of carbon.

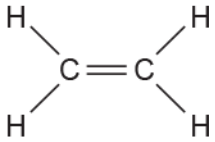
Look at the displayed formulae of ethane, propane and ethene.



Ethane

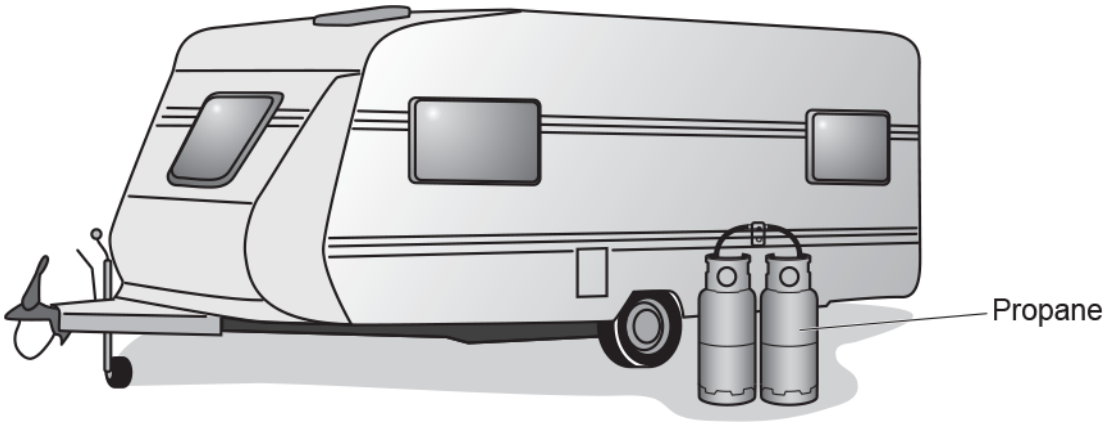


Propane



Ethene

* Propane gas is used as a fuel for cooking and heating in caravans.



Incomplete combustion of propane can occur if the campers do not take sensible precautions.

Describe how incomplete combustion of hydrocarbons such as propane happens and the problems it can cause for campers.

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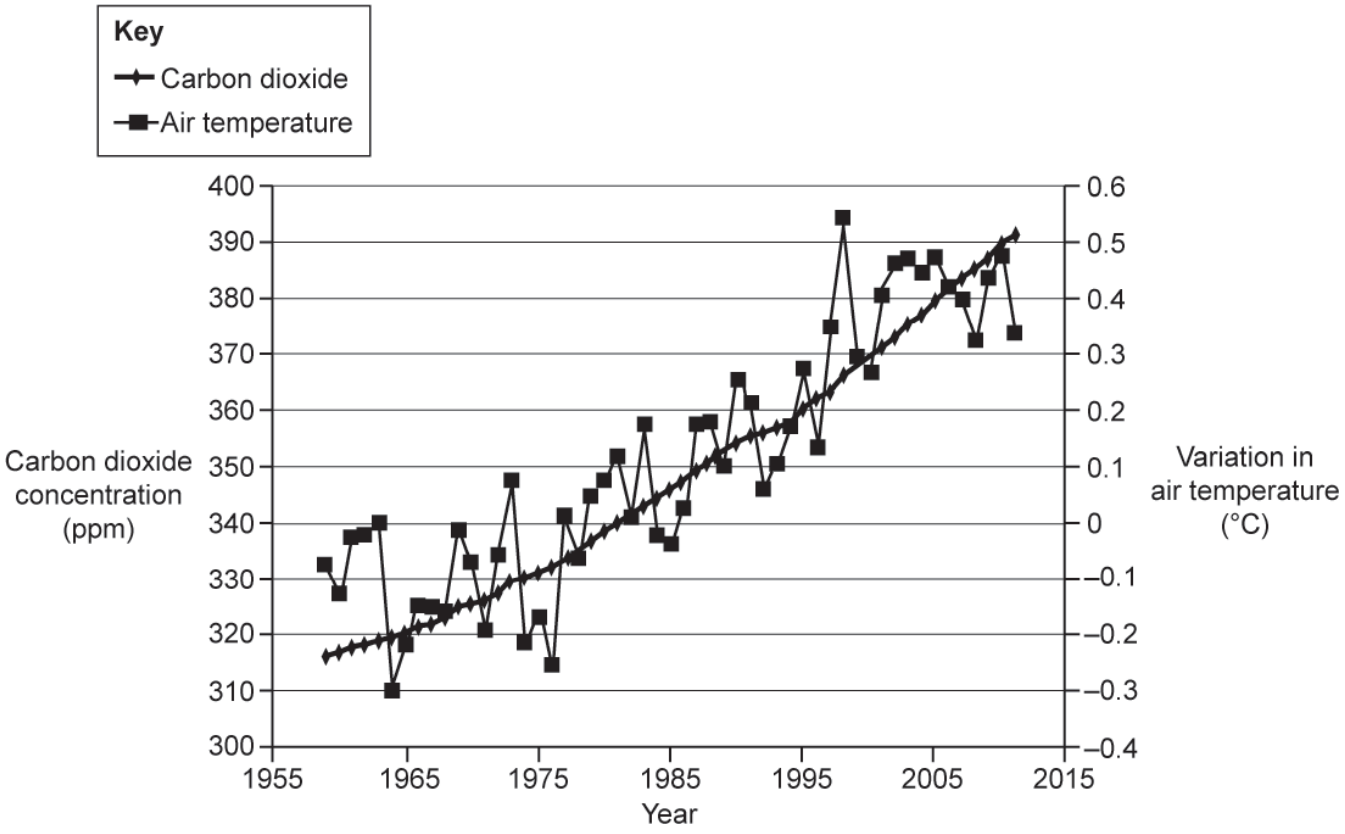
Include a **balanced symbol** equation in your answer.

[6]

54(a) This question is about the Earth's atmosphere.

The graph shows how carbon dioxide concentration and air temperature have changed between 1955 and 2015.

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Evaluate the information shown in the graph.

To what extent does the graph support a link between carbon dioxide levels and global warming?

---

[2]

(b) Describe and explain what is meant by the **greenhouse effect**.

---

[3]

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(c) Many scientists believe an **enhanced greenhouse effect** is caused by human activities.

(i) State a **human activity** that can cause an enhanced greenhouse effect.

---

[1]

(ii) State **two** environmental effects of an enhanced greenhouse effect.

1 ---

---

2 ---

---

[2]

END OF QUESTION PAPER