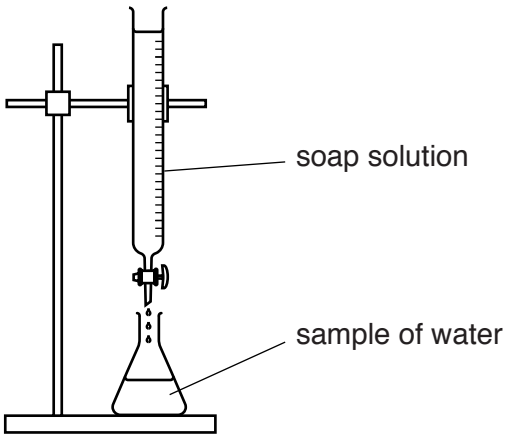
1 Kate is testing some samples of water with soap solution.

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



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

(a) 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.

.....

.....

.....

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.....

..... **[4]**

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

Explain how washing soda softens hard water.

.....

.....

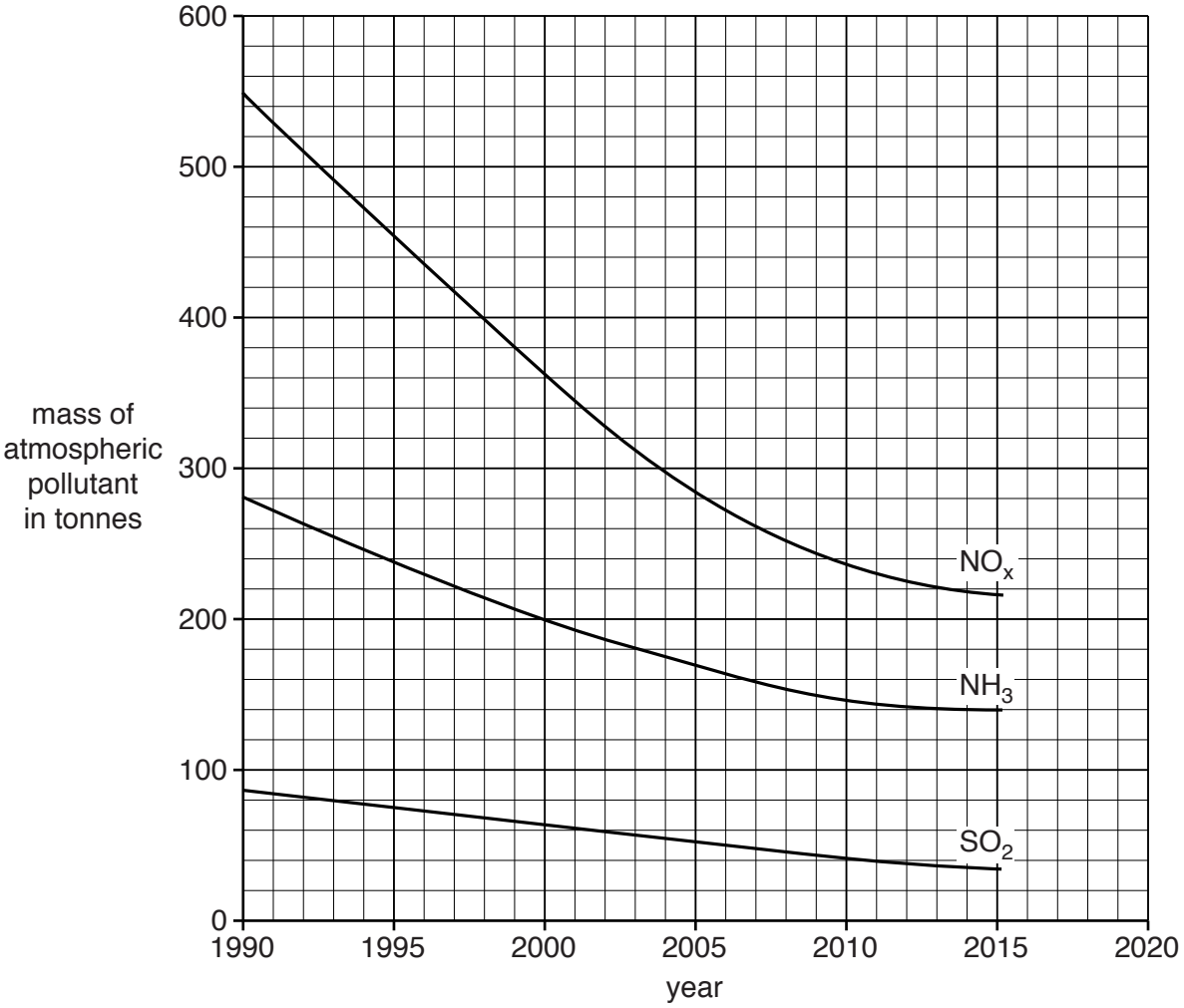
..... **[2]**

2 This question is about air pollution.

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

(a) Look at the graph.

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



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

Explain your answer.

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..... **[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?

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.

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.....

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.....

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

3 This question is about the structure of the Earth.

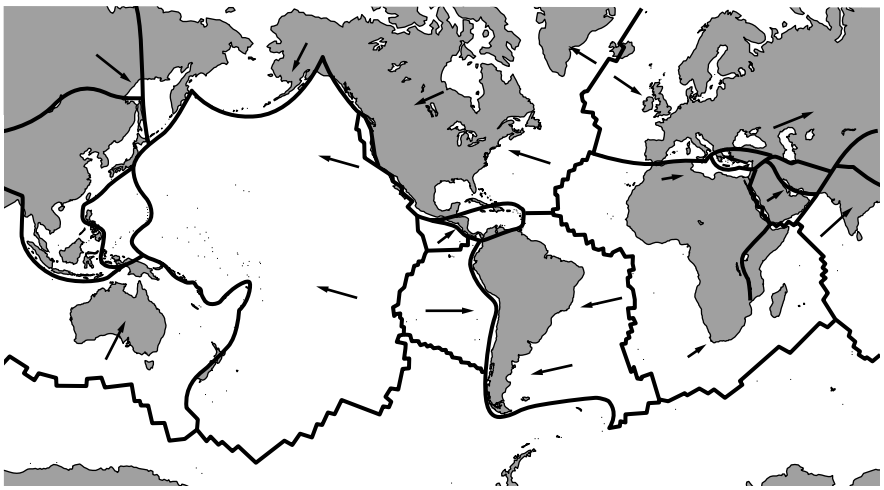
(a) It is difficult for scientists to study the structure of the Earth.

Explain why.

.....

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

(b) The Earth's crust is made up of tectonic plates that move slowly.



The **theory of plate tectonics** developed over many years.

(i) Write about **two** stages in the **development** of the theory of plate tectonics.

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.....

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

(ii) Why do most scientists now accept this developed theory?

.....

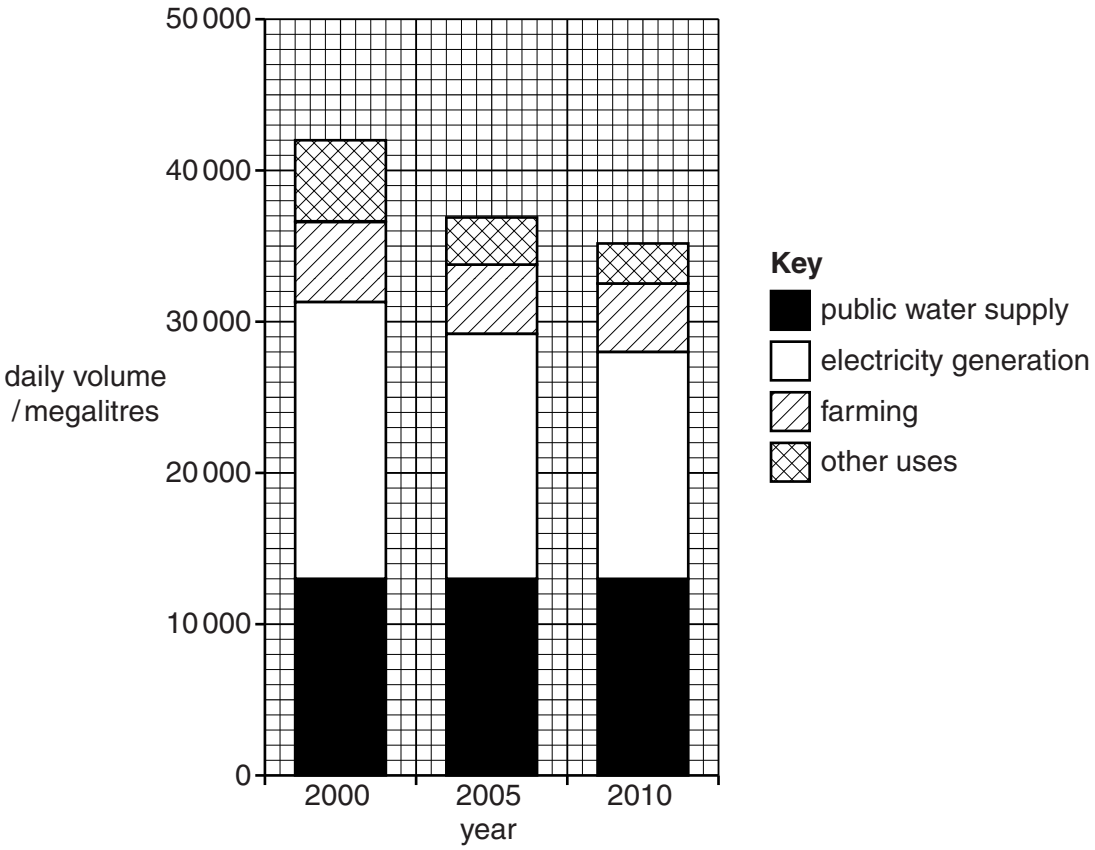
..... **[1]**

[Total: 4]

4 Water is a very important resource in the world.

(a) 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.

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.

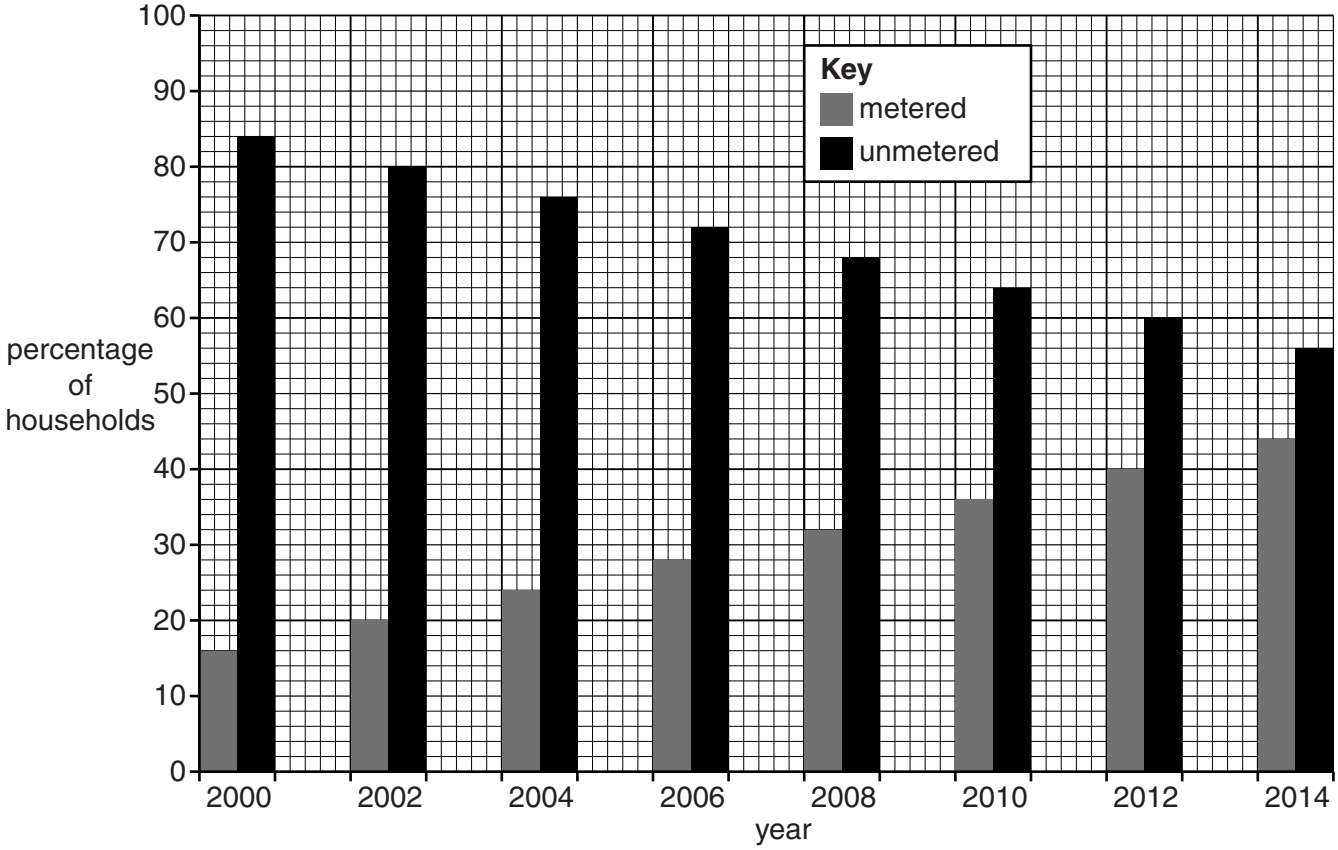
..... **[1]**

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

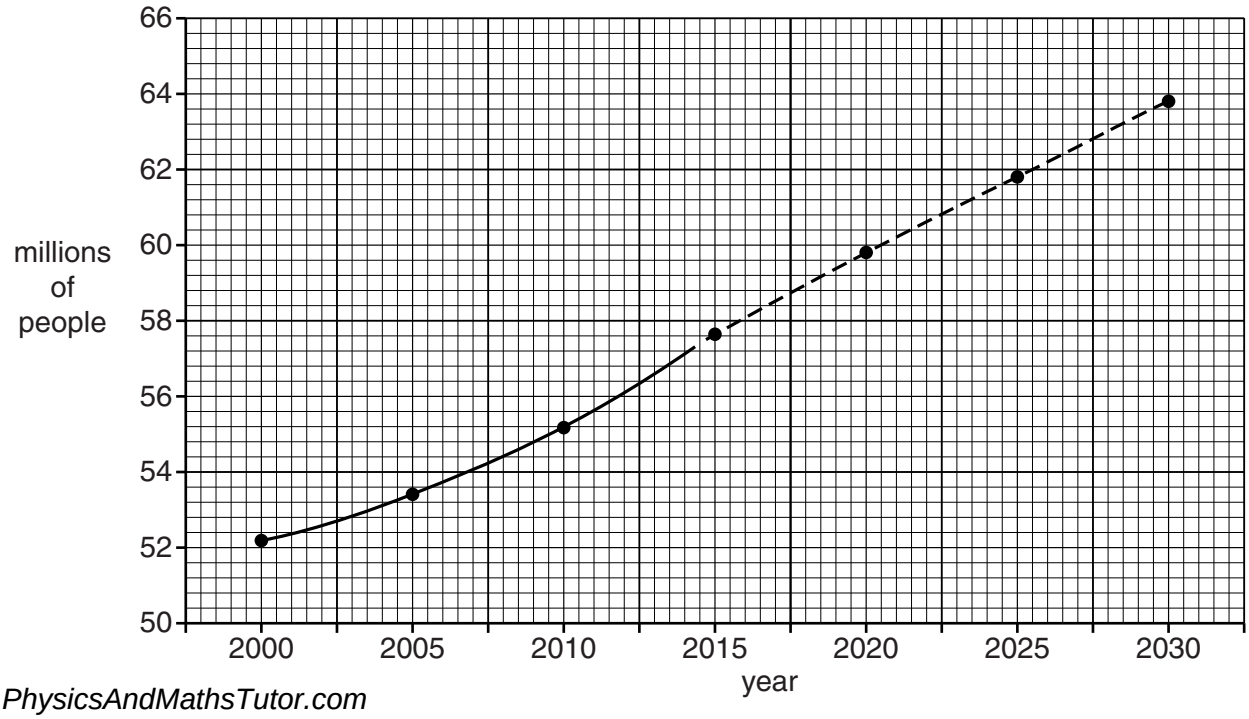
- Number of water meters fitted – people use much less water when they have a water meter fitted in their house
- Population
- Leakage of water from water pipes

Look at the information about these three factors.

Households with water meters in England and Wales 2000 to 2014



Population trends in England and Wales 2000 to 2030



Leakage of water between the years 2000 and 2014

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.

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..... **[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]**

[Total: 10]

5 This question is about the gases in the air.

(a) 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]**

(c)

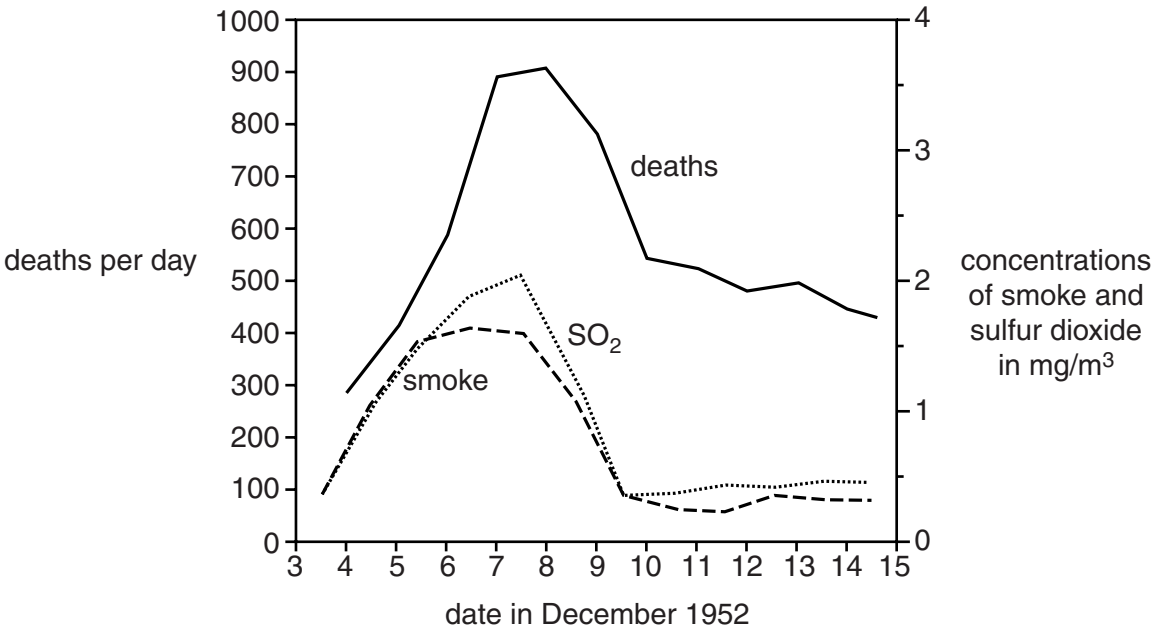
Air quality in the UK has improved over the last 60 years.

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.



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

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

[Total: 9]

6 This question is about the structure of the Earth.

(a) Look at the table of densities.

Layer of Earth	Density in g/cm^3
crust	2.2 – 3.9
outer mantle	3.4 – 4.4
inner mantle	4.4 – 5.6
outer core	9.9 – 12.2
inner core	12.8 – 13.1

The lithosphere includes the crust and outer part of the mantle.

The lithosphere is made of tectonic plates.

Some scientists claim that these tectonic plates **'float'** on the inner mantle.

How does the data in the table help to support this claim?

.....

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

(b) In 1914, Wegener proposed a theory to explain the structure of the Earth.

This was not accepted by many scientists at the time.

His original theory has now been developed into the theory of plate tectonics.

This developed theory is more widely accepted.

Explain why developed theories are often more widely accepted.

.....

.....

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

[Total: 3]

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

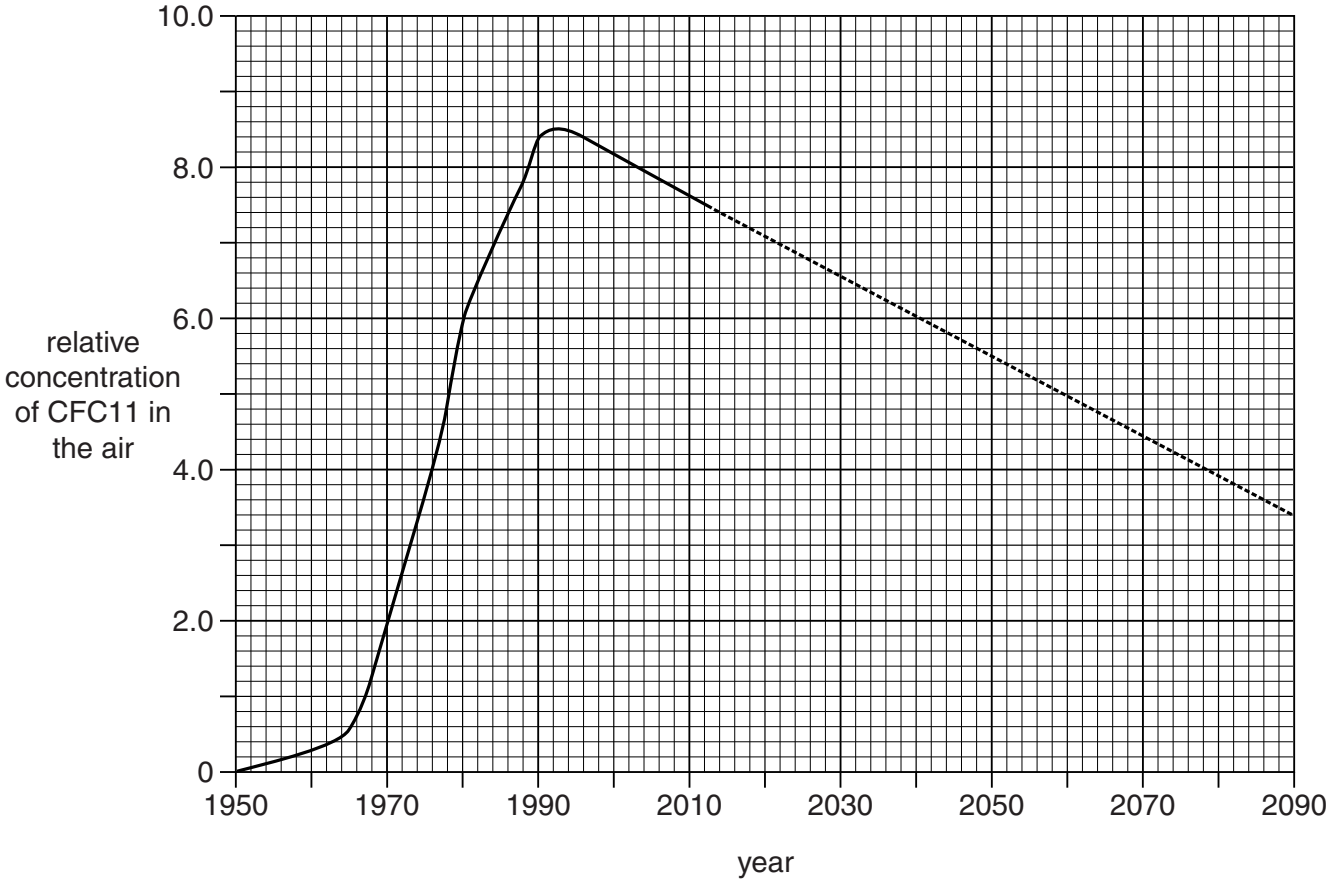
Chlorofluorocarbons, CFCs, are pollutants found in the air.

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.

.....

..... **[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?

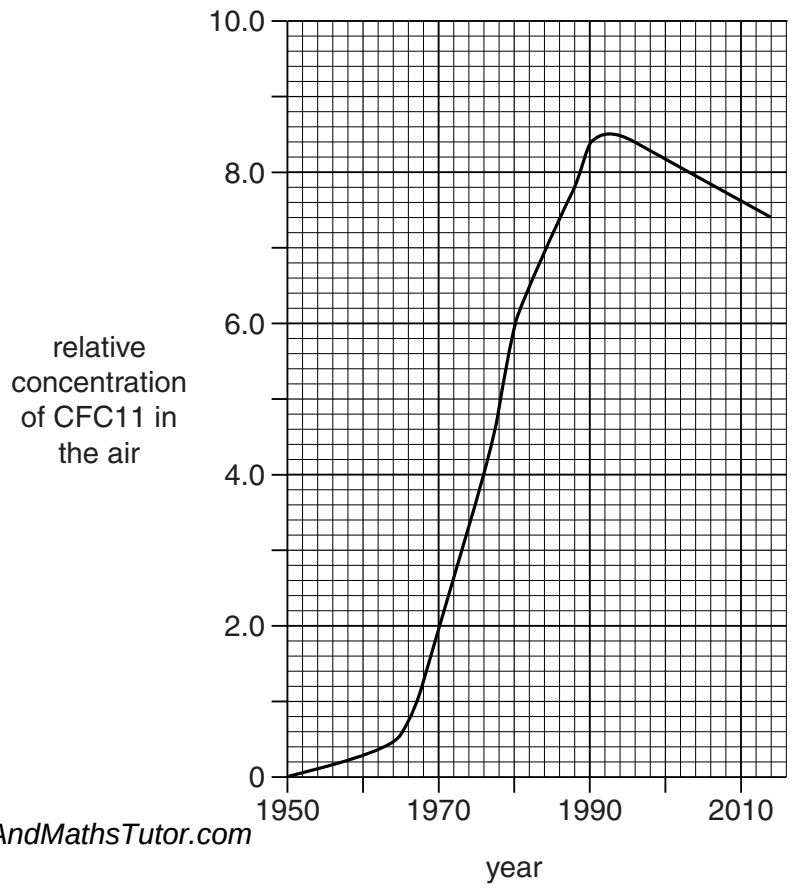
.....

..... **[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]