

1 Planet Earth

Definitions to learn

- ♦ **acid rain** rainfall with a pH usually less than 5 resulting from dissolved atmospheric pollution
- ♦ **greenhouse gas** a gas which absorbs heat (infrared radiation) and keeps the surface of the planet warm
- ♦ **photosynthesis** the photochemical reaction in the green leaves of plants that turns carbon dioxide and water into glucose and oxygen
- ♦ **respiration** the biochemical reaction in living cells that produces energy from the reaction of glucose and oxygen to produce carbon dioxide and water

Useful equations

carbon dioxide + water → glucose + oxygen	$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$	photosynthesis
glucose + oxygen → carbon dioxide + water	$\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$	respiration

Exercise 1.1 Global warming and the ‘greenhouse effect’

This exercise will help in developing your skills at processing unfamiliar data and making deductions from novel sources.

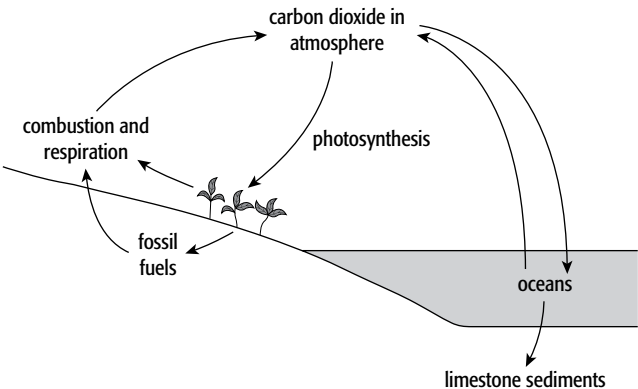
S The diagram shows a simplified carbon cycle.

a Describe the process of photosynthesis in simple terms.

.....

.....

.....



The ‘greenhouse effect’ is caused by heat from the Sun being trapped inside the Earth’s atmosphere by some of the gases which are present – their molecules absorb infrared radiation. As the amount of these ‘greenhouse gases’ increases, the mean (average) temperature of the Earth increases. It is estimated that, if there were no ‘greenhouse effect,’ the Earth’s temperature would be cooler by 33 °C on average. Some of the gases which cause this effect are carbon dioxide, methane and oxides of nitrogen (NO_x).

Global warming: Since the burning of fossil fuels started to increase in the late nineteenth century, the amount of carbon dioxide in the atmosphere has increased steadily. The changes in the mean temperature of the Earth have not been quite so regular. Below are some data regarding the changes in mean temperature of the Earth and amount of carbon dioxide in the atmosphere. The first table (Table 1) gives the changes over recent years, while the second table gives the longer-term changes (Table 2). The mean temperature is the average over all parts of the Earth's surface over a whole year. The amount of carbon dioxide is given in ppm (parts of carbon dioxide per million parts of air).

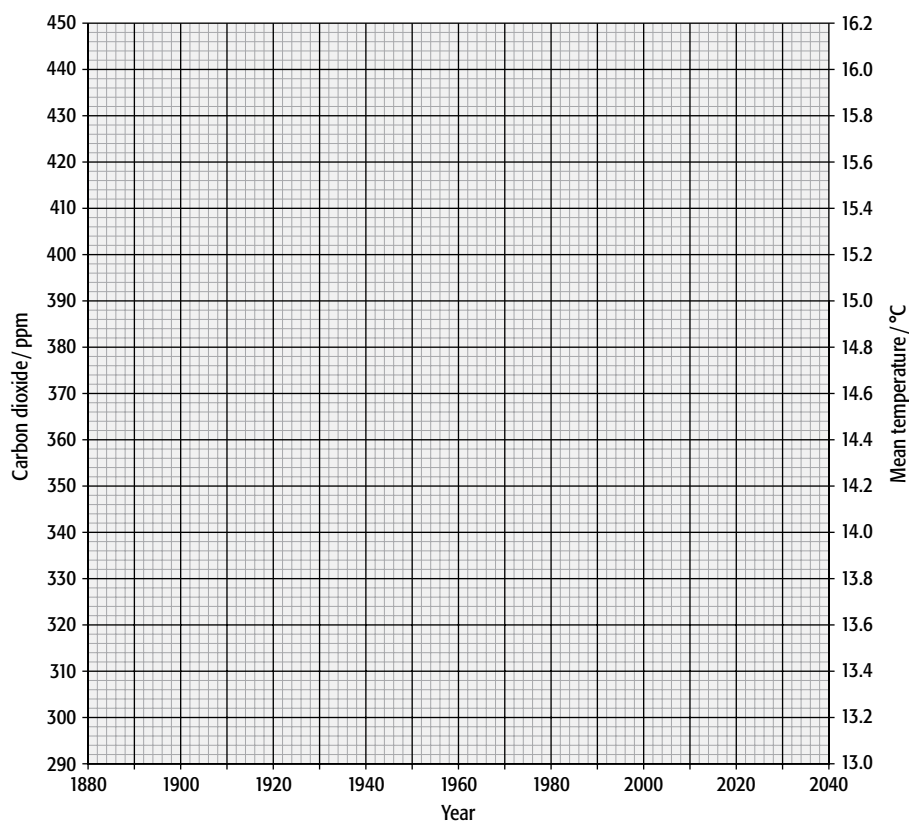
Year	CO ₂ / ppm	Mean temperature / °C
1982	340	14.08
1984	343	14.15
1986	347	14.19
1988	351	14.41
1990	354	14.48
1992	356	14.15
1994	358	14.31
1996	361	14.36
1998	366	14.70
2000	369	14.39
2002	373	14.67
2004	377	14.58
2006	381	14.63
2008	385	14.51
2010	390	14.69
2012	394	14.59

Table 1

Year	CO ₂ / ppm	Mean temperature / °C
1880	291	13.92
1890	294	13.81
1900	297	13.95
1910	300	13.80
1920	303	13.82
1930	306	13.96
1940	309	14.14
1950	312	13.83
1960	317	13.99
1970	324	14.04
1980	338	14.28

Table 2

- b** Plot these results on the grid using the left-hand *y*-axis for amount of carbon dioxide and the right-hand *y*-axis for mean temperature. Draw two separate graphs to enable you to compare the trends. (Use graph paper if you need a larger grid.)
- c** What do you notice about the trend in amount of carbon dioxide?
- d** What do you notice about the trend in mean temperature?



- e Does the graph clearly show that an increase in carbon dioxide is causing an increase in temperature?
.....
.....

- f Estimate the amount of carbon dioxide in the atmosphere and the likely mean temperature of the Earth in the years 2020 and 2040.
.....
.....

- g Between the eleventh century and the end of the eighteenth century the amount of carbon dioxide in the atmosphere varied between 275 and 280 ppm. Why did it start to rise from the nineteenth century onwards.
.....

- h Other ‘greenhouse gases’ are present in much smaller amounts. However, they are much more effective at keeping in heat than carbon dioxide. Methane (1.7 ppm) has 21 times the effect of carbon dioxide. Nitrogen oxides (0.3 ppm) have 310 times the effect of carbon dioxide.

Name a source that releases each of these gases into the atmosphere.

Methane:

Nitrogen oxides:



Use the checklist below to give yourself a mark for your graph.

For each point, award yourself:

2 marks if you did it really well

1 mark if you made a good attempt at it, and partly succeeded

0 marks if you did not try to do it, or did not succeed.

Self-assessment checklist for graphs:

Check point	Marks awarded	
	You	Your teacher
You have plotted each point precisely and correctly for both sets of data – using the different scales on the two vertical axes.		
You have used a small, neat cross or dot for the points of one graph.		
You have used a small, but different, symbol for the points of the other graph.		
You have drawn the connecting lines through one set of points accurately – using a ruler for the lines.		
You have drawn the connecting lines through the other set of points accurately – using a different colour or broken line.		
You have ignored any anomalous results when drawing the lines.		
Total (out of 12)		

10–12 Excellent.

7–9 Good.

4–6 A good start, but you need to improve quite a bit.

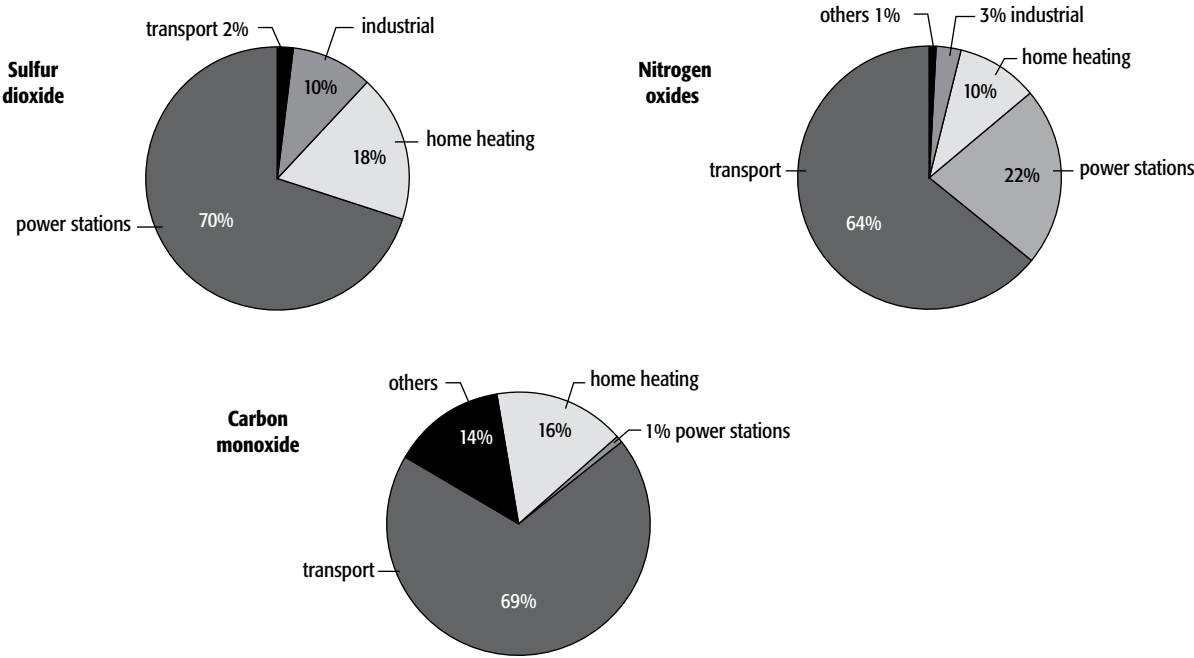
2–3 Poor. Try this same graph again, using a new sheet of graph paper.

1 Very poor. Read through all the criteria again, and then try the same graph again.

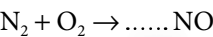
Exercise 1.2 Atmospheric pollution, industry and transport

This exercise discusses different aspects of atmospheric pollution and relates it to key aspects of human activity. It will help you in developing your skills in evaluating data and drawing conclusions from them.

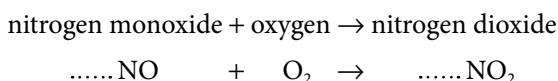
The following pie charts show estimates of the sources of three major atmospheric pollutants in an industrialised country.



- a What is the largest source of sulfur dioxide pollution?
.....
- b Name the **three** major fuels whose combustion gives rise to the levels of sulfur dioxide in the atmosphere.
.....
- c Units are being added to the some power stations and industrial plants to prevent the emission of sulfur dioxide. What is the name given to these units?
.....
- d Nitrogen oxides (NO_x) are another major pollutant of the atmosphere, particularly in large cities.
 - i Nitrogen monoxide is formed by the reaction of nitrogen and oxygen inside the hot engine of cars and other vehicles. Complete the following equation for the reaction producing nitrogen monoxide.



- S** **ii** When leaving the car, nitrogen monoxide in the exhaust fumes reacts further with oxygen in the air to produce the brown gas which can be seen in the atmosphere over large cities. This gas is nitrogen dioxide. Balance the equation for the production of this gas.



- iii** The operating temperature of a diesel engine is significantly higher than that of a petrol (gasoline) engine. Would you expect the level of NO_x emissions from a diesel-powered vehicle to be greater or lower than from a petrol-powered vehicle? Give the reason for your answer.

.....

.....

- iv** What attachment is fitted to modern cars to reduce the level of pollution by oxides of nitrogen?

.....

- e** Nitrogen oxides, unburnt hydrocarbons and carbon monoxide combine together under the influence of ultraviolet light to produce photochemical smog.

- i** Why do you think this form of pollution is most common in large cities?

.....

.....

- ii** What other form of pollution from car exhaust fumes has now almost totally disappeared from modern cities following changes in fuel and pollution monitoring?

.....

- f** In order to control traffic flow, London introduced a 'congestion charge' for vehicles entering the centre of the city in 2003. The table shows figures for the percentage fall in the levels of certain pollutants following the introduction of the congestion charge.

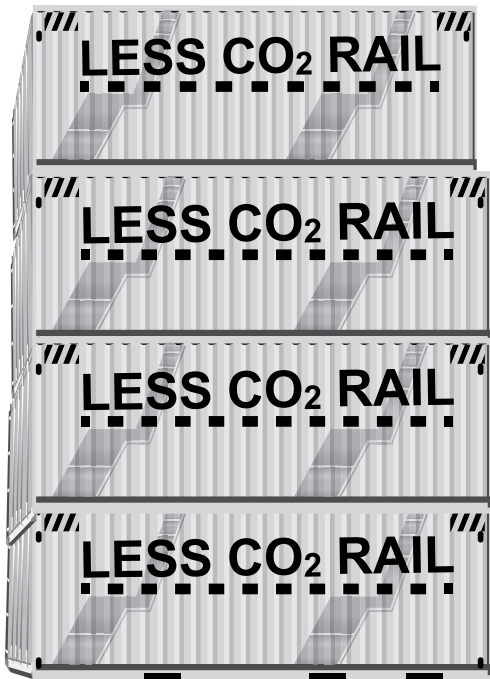
	Pollutant gas within Congestion Charge Zone	
	NO_x	CO_2
Overall traffic emissions change 2003 versus 2002 / %	−13.4	−16.4
Overall traffic emissions change 2004 versus 2003 / %	−5.2	−0.9
Change due to improved vehicle technology, 2003 to 2006 / %	−17.3	−3.4

- i** What was the measured percentage drop in the level of nitrogen oxides within the Congestion Charge Zone over the first two years following the introduction of the charge?

.....

.....

- S**
- ii At face value there seems to be a drop in the levels of pollutants following the introduction of the congestion charge. But should we expect the fall in pollution levels to continue?
 - iii An independent study published in 2011 suggested that other factors should be taken into account, particularly when trying to study a relatively small area within a large city. One factor is hinted at in the third row of figures. What is that factor; and what other influences need to be taken into account in considering this situation?
- g** The use of fossil fuels in industry and transport also produces carbon dioxide. What is the reasoning behind the slogan painted on these freight containers seen waiting to be loaded on to a freight train outside a major UK station? Outline the argument behind the slogan.

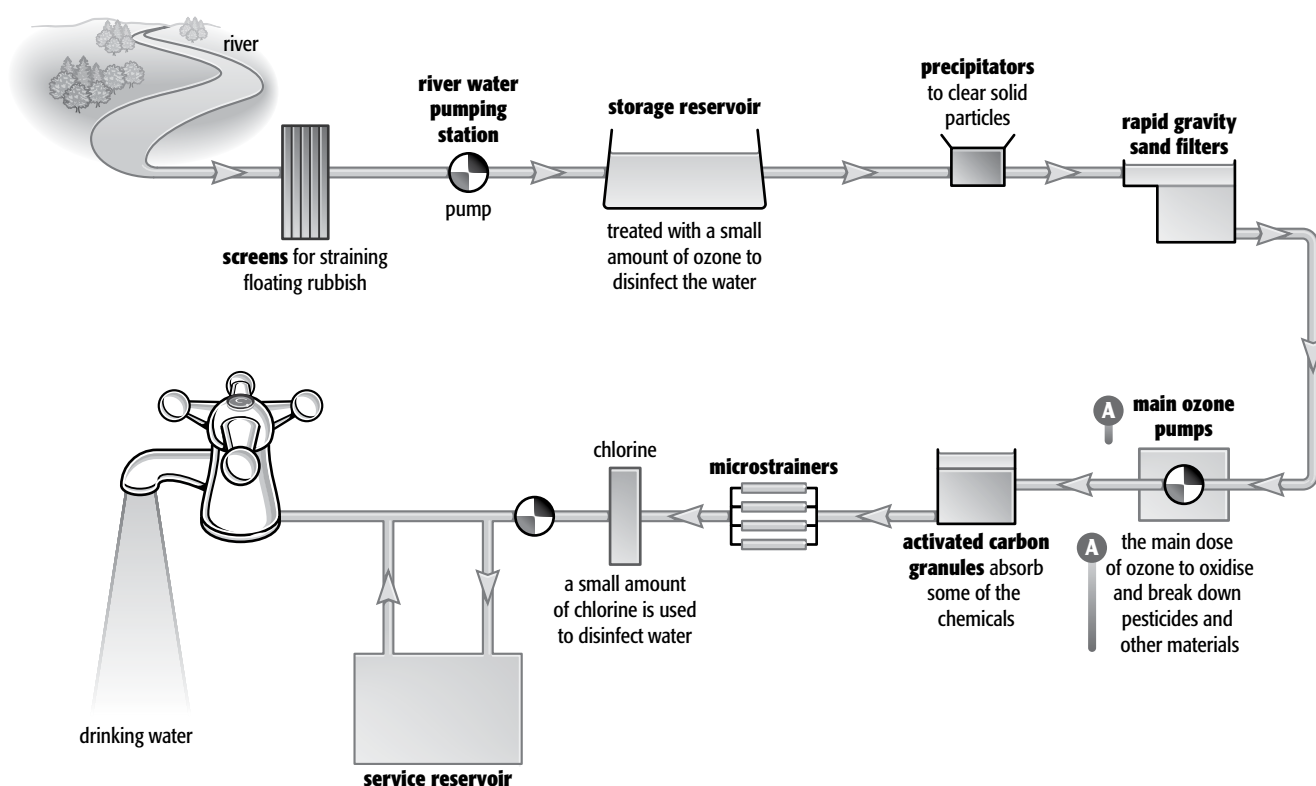


Exercise 1.3 Clean water is crucial

This exercise covers aspects of how we produce clean water for domestic and industrial use, focusing on stages that depend on key physical and chemical techniques.

The provision of clean drinking water and sanitation to more of the world's population is one of the key millennium goals of the United Nations. The lack of this basic provision impacts not only on the levels of disease in an area, in particular the mortality rate of children, but also on the level of education and the role of women within a community.

The diagram shows the different stages involved in a modern water plant producing water for domestic and industrial use.



- a What devices are used in the early stages of processing to remove insoluble debris and material? Include comments on the size of the material removed by these methods.

.....

.....

.....

- b What is the common purpose of treating the water with chlorine and/or ozone?

.....

c What other purpose does treatment with ozone achieve?

.....

A d What type of chemical agent is ozone (O₃) behaving as in the reactions involved in part c?

.....

e Countries that have insufficient rainfall, or where water supply is in great demand, may need to use other methods of producing clean water. Here, processes for **desalination** are used.

i What does the term **desalination** mean?

.....

ii Name **two** methods that such countries use for desalination.

.....

iii Give **one** disadvantage of these methods of desalination.

.....

f Tap water produced by this type of treatment is clean, but it is not pure. It will contain metal and non-metal ions dissolved from the rocks that the rivers and streams have flowed over.

i Chloride ions are present in tap water. Describe a chemical test that would show the presence of chloride ions (Cl⁻) in the water. Describe the test and what would be observed.

.....

.....

.....

ii One of the chlorides often present in tap water is sodium chloride. Give the word and balanced symbol equation for the reaction taking place in the test you have described above.

sodium chloride + → +

.....

NaCl + → +

S iii Give the ionic equation for the reaction taking place (include state symbols).

.....

Exercise 1.4 Gases in the air

This exercise discusses how the composition of the Earth's atmosphere has been influenced by volcanic emissions over the duration of the life of the planet. It looks at how the composition of the atmosphere has changed and how we purify the different gases from the air.

There have been several spectacular volcanic eruptions in recent years. In 2010, clouds of ash from the relatively small eruption of the Eyjafjallajökull volcano in Iceland caused disruption in most of European airspace throughout the month of April.

The diagram shows the spread of the volcanic ash cloud over Europe during April 2010.

