AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.9.3.1

Atmospheric pollutants from fuels

Past-paper questions

Tier	**Higher**
Question groups	**74**
Available paper years	**2007–2024**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

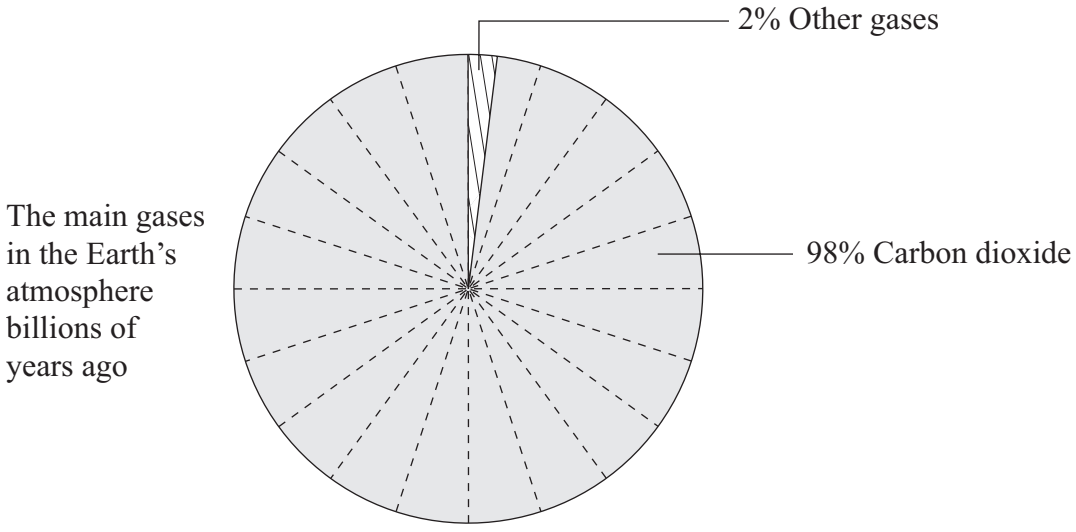
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.9.3.1 Atmospheric pollutants from fuels

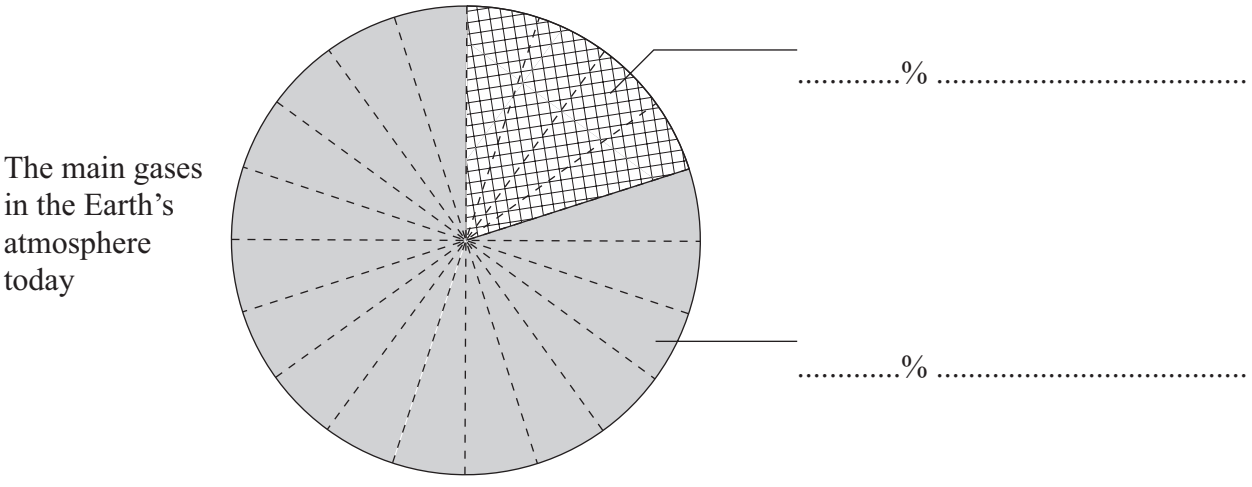
Question 01

January 2007 | CHY1H | Original Q2 | Legacy

2 Life on Earth would not exist without the atmosphere.
Billions of years ago the composition of the Earth's atmosphere was very different from the composition today.



(a) Label the pie chart below to show the percentages and names of the two main gases in the Earth's atmosphere today.



(2 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 01 · continued

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(b) There is evidence that the composition of the Earth's atmosphere is still changing. One possible reason is that many power stations generate electricity by burning fossil fuels such as coal, oil or natural gas. Sulfur dioxide, SO_2, is produced when coal burns in air.

(i) What environmental problem does sulfur dioxide cause?

.....

.....

(1 mark)

(ii) How could this environmental problem be reduced in coal-fired power stations?

.....

.....

(1 mark)

(iii) Gas-fired power stations burn methane, CH_4, in air.

Complete the word equation for this reaction.

methane + ... → carbon dioxide + ...

(2 marks)

(c) Excess carbon dioxide should be prevented from entering the atmosphere.

Explain why.

.....

.....

.....

.....

(2 marks)

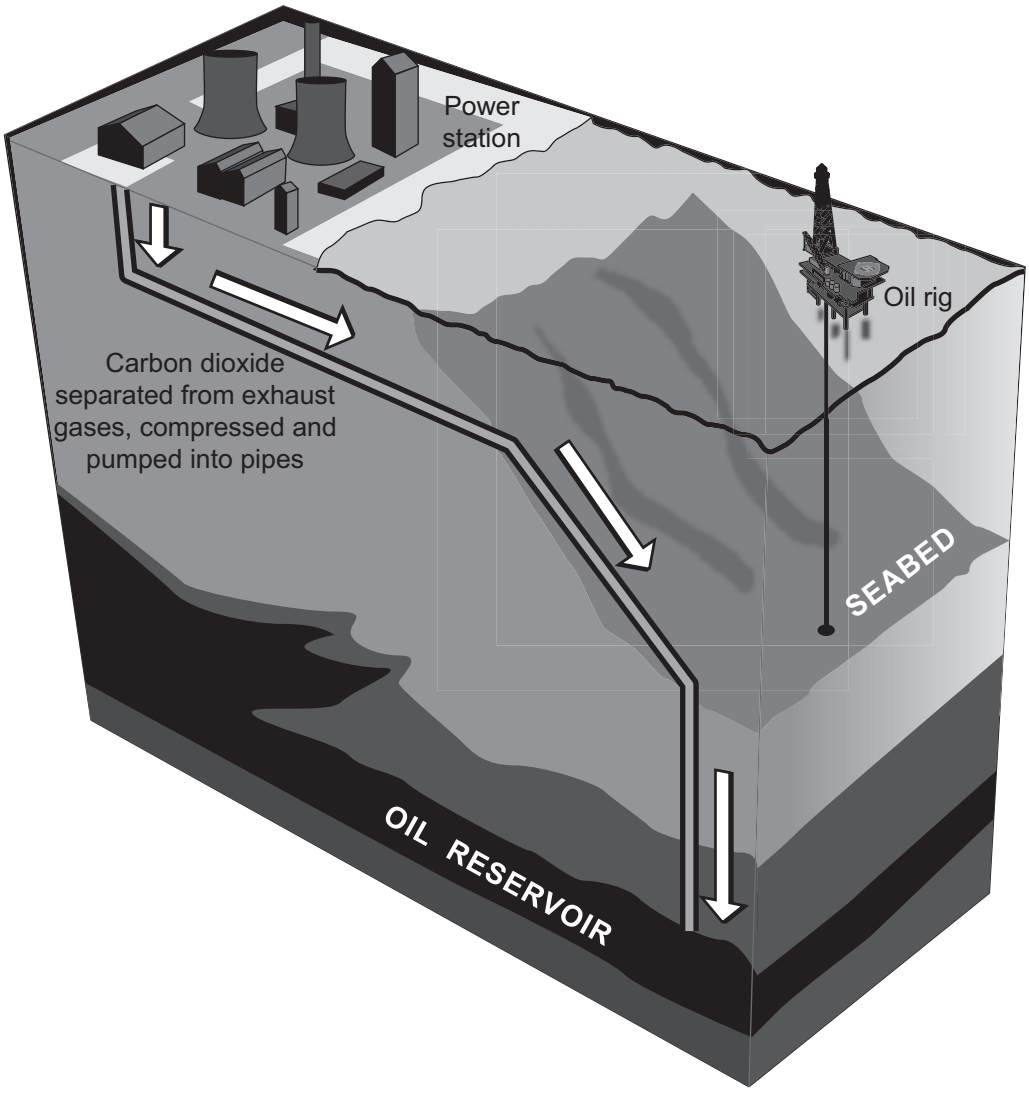
Question 2 continues on the next page

4.9.3.1 Atmospheric pollutants from fuels

Question 01 · continued

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(d) Carbon dioxide is produced when fossil fuels burn in power stations. The diagram represents one idea to prevent excess carbon dioxide from entering the atmosphere.



Use the diagram to explain how carbon dioxide can be prevented from entering the atmosphere.

.....

.....

.....

.....

(2 marks)

10

4.9.3.1 Atmospheric pollutants from fuels

Question 02

March 2007 | CHY1A | Original Q3 | Legacy

QUESTION THREE

Crude oil is a non-renewable energy source. Petrol is a fuel obtained from the fractional distillation of crude oil.

Gasohol is also a fuel. It is a mixture of 90 % petrol and 10 % ethanol. The ethanol can be produced from the waste stems and leaves when crops have been harvested. So ethanol is a renewable energy source.

	Mass in grams of gas produced by completely burning 10 cm^3 of fuel		
Fuel	Carbon dioxide from petrol	Carbon dioxide from ethanol	Water vapour
Petrol	26.4	0	12.6
Gasohol	23.8	1.5	12.2

3A What is the total mass of carbon dioxide produced when 10 cm^3 of gasohol is burned?

1 22.3 g

2 23.8 g

3 25.3 g

4 26.4 g

3B How much more carbon dioxide is produced when 10 cm^3 of petrol is burned than when 10 cm^3 of gasohol is burned?

1 0.4 g

2 1.1 g

3 1.6 g

4 24.9 g

4.9.3.1 Atmospheric pollutants from fuels

Question 02 · continued

3C Why is the water vapour produced by burning fuels not a problem?

1 It condenses to a liquid.

2 It does not cause corrosion.

3 It is not a pollutant.

4 Very little is produced.

3D Carbon dioxide causes environmental problems.

Why is carbon dioxide from burning ethanol thought to be less of a problem than carbon dioxide from burning petrol?

1 Not as much carbon dioxide is produced.

2 The carbon dioxide produced has different chemical properties.

3 It is just recycling carbon dioxide removed from the air by plants.

4 The ethanol is not produced from crude oil.

4.9.3.1 Atmospheric pollutants from fuels

Question 03

March 2007 | CHY1A | Original Q7 | Legacy

QUESTION SEVEN

In the engine cylinders of petrol-driven cars, a mixture of petrol and air is ignited.

- Petrol consists mainly of alkanes in the $C_5 - C_{10}$ range.
- Air consists of nitrogen (79 %), oxygen (20 %) and small amounts of other gases.

The petrol/air mixture is ignited by an electrical spark causing an explosive reaction to drive the pistons in the cylinders.

Some of the elements in the petrol/air mixture combine with oxygen at the very high temperatures reached.

Modern engines are very efficient but are still not capable of complete combustion. The gases produced during combustion are released as exhaust gases.

The table shows some of the exhaust gases from a typical petrol engine.

Gas	Percentage
carbon dioxide	15.0
carbon monoxide	1.0
oxygen	0.7
hydrocarbons	0.05
nitrogen oxides	0.2
sulfur dioxide	0.007

7A The gases in the table make up less than 20 % of the exhaust gases.

Which substance will make up most of the remainder of the exhaust gases?

1 hydrogen

2 methane

3 nitrogen

4 water vapour

4.9.3.1 Atmospheric pollutants from fuels

Question 03 · continued March 2007 | CHY1A | Original Q7 | Legacy

7B One piece of evidence that suggests there is incomplete combustion is . . .

1 the high percentage of carbon dioxide.

2 the presence of carbon monoxide.

3 the presence of nitrogen oxides.

4 the low percentage of sulfur dioxide.

Nitrogen oxides are acidic oxides.
The equation shows how nitrogen monoxide is formed in the cylinders.

$$N_2 + O_2 \rightarrow 2NO$$

7C Nitrogen monoxide reacts with more oxygen to produce nitrogen dioxide.

Which is the correct equation for this reaction?

1 $N_2 + O_2 \rightarrow NO_2$

2 $NO + O_2 \rightarrow NO_2$

3 $2NO + O_2 \rightarrow 2NO_2$

4 $2NO + 2O_2 \rightarrow 2NO_2$

7D Why is it important to remove nitrogen oxides from the exhaust gases?

1 They are brown gases.

2 They can cause global dimming.

3 They can cause acid rain.

4 They cause carbon deposits in the exhaust pipe.

4.9.3.1 Atmospheric pollutants from fuels

Question 04

March 2007 | CHY1B | Original Q9 | Legacy

QUESTION NINE

Read this extract from a magazine article.

BIODIESEL

Biodiesel is a fuel made by the chemical reaction of alcohol with vegetable oils such as soya bean oil. This process also produces glycerine which is used in soap making.

Biodiesel can be used in engines which normally run on petroleum diesel. Biodiesel can be mixed with petroleum diesel in any proportions.

Biodiesel is biodegradable and contains very little sulfur. The complete combustion of biodiesel forms more carbon dioxide, less carbon monoxide and much less particulate, smoke-type emissions than petroleum diesel.

Some of the disadvantages of biodiesel include attacking engine hoses that were intended for a different fuel and loosening deposits within the engine left from previous fuels which can cause blockages.

9A The main advantage of using biodiesel instead of petroleum diesel is that . . .

1 it does not cause any damage to engines.

2 it guarantees the soap industry a plentiful supply of glycerine.

3 it increases the amount of carbon dioxide released into the atmosphere.

4 it is a renewable fuel.

9B From the information given, it is possible to conclude that biodiesel will contribute to . . .

1 a decrease in acid rain formation.

2 an increase in fog formation.

3 a decrease in soap production.

4 a reduction in global warming.

4.9.3.1 Atmospheric pollutants from fuels

9C Which one of the following is a correct statement?

1 Biodiesel production will eventually make the distillation of crude oil unnecessary.

2 During combustion, fewer toxic emissions are produced by petroleum diesel than by biodiesel.

3 Plants used to make biodiesel use up carbon dioxide as they grow, so offsetting the carbon dioxide produced when the fuel burns.

4 There is nothing to limit the amount of crops a country can grow economically each year to produce biodiesel.

9D Which of the following statements about biodiesel compared with petroleum diesel is **not** based on scientific measurements?

1 Both the fuel and its combustion products are less carcinogenic than ordinary diesel.

2 For transportation, biodiesel is classed as less flammable than petroleum diesel.

3 The exhaust gases from a biodiesel-fuelled engine contain less unburnt hydrocarbons.

4 Biodiesel has a much more pleasant odour than petroleum diesel.

END OF TEST

4.9.3.1 Atmospheric pollutants from fuels

Question 05

June 2007 | CHY1A | Original Q8 | Legacy

QUESTION EIGHT

Exhaust fumes from petrol-driven cars contain harmful gases, particularly acidic nitrogen oxide, poisonous carbon monoxide and unburned hydrocarbons.

Catalytic converters are fitted to these cars to help to reduce the quantities of these gases released into the atmosphere. The reaction in the converter can be summarised by this equation:

carbon monoxide + nitrogen oxide → carbon dioxide + nitrogen

The catalysts in the converters usually contain a mixture of two transition metals, platinum and rhodium.

These metals occur in the Earth's crust mainly with copper and nickel sulfide ores.
To extract the metals, the ores are roasted in air which produces sulfur dioxide.

8A The balanced, symbol equation for the reaction between carbon monoxide and nitrogen oxide is . . .

1 $2CO + 2NO \rightarrow 2CO_2 + N_2$

2 $CO + NO \rightarrow CO_2 + N_2$

3 $2CO + 2NO \rightarrow CO_2 + N_2$

4 $2CO + 2NO \rightarrow CO_2 + 2N_2$

8B Which substance is reduced in this reaction?

1 carbon monoxide

2 carbon dioxide

3 nitrogen oxide

4 nitrogen

8C Why do some environmental organisations question the benefits of catalytic converters?

1 They are expensive to manufacture and make cars more expensive.

2 Polluting gases are released both in producing them and in using them.

3 They do not remove any of the harmful gases from the exhaust fumes.

4 Nitrogen is a poisonous gas.

4.9.3.1 Atmospheric pollutants from fuels

8D What conclusion about the use of catalytic converters can safely be made from the information in this question?

1 Transition metals are good conductors of heat and electricity.

2 There are no harmful gases in the exhaust fumes from a car fitted with a catalytic converter.

3 A catalytic converter reduces the amount of carbon monoxide in the exhaust fumes from a petrol-driven car.

4 Catalytic converters work equally well in both diesel-driven and petrol-driven cars.

Turn over for the next question

4.9.3.1 Atmospheric pollutants from fuels

Question 06

November 2007 | CHY1A | Original Q3 | Legacy

QUESTION THREE

The table shows the emissions of sulfur dioxide, in the United Kingdom (UK), by different fuels in 1990 and in 2004.

	Emissions of sulfur dioxide by different fuels in thousands of tonnes		
Fuel type	**1990**	**2004**	**Percentage change between 1990 and 2004**
Coal	2707	578	–79
Other solid fuels	66	20	–70
Petroleum fuel oil	605	78	–87
Other petroleum products (including petrol and diesel)	193	83	–57
Gaseous fuels	9	11	+22
Other emissions of sulfur dioxide	118	58	–51
TOTAL	**3698**	**828**	**–78**

- Since 1990, the amount of coal used in the generation of electricity at power stations has reduced by more than 60%.
- Since 1990, gaseous fuels have gradually been replacing fuel oil for electricity generation and in industry.
- The small amount of sulfur dioxide emitted from petrol and diesel fuel used in vehicles has decreased. It should decrease further with the increased use of low-sulfur petrol and diesel.

4.9.3.1 Atmospheric pollutants from fuels

Question 06 · continued

3A Which fuel had the largest reduction in sulfur dioxide emissions, **in thousands of tonnes**, between 1990 and 2004?

1 coal

2 fuel oil

3 other petroleum products

4 gaseous fuels

3B This data suggests that emissions of sulfur dioxide between 1990 and 2004 . . .

1 decreased for all fuels.

2 decreased by more than 50% for all fuels.

3 decreased by 78% for all fuels except gaseous fuels.

4 decreased by more than 50% for all fuels except gaseous fuels.

3C Which reasonable prediction can be made from the evidence given at the beginning of this question?

1 Sulfur dioxide emissions will begin to increase in the future as the number of vehicles on our roads increases.

2 Overall, sulfur dioxide emissions are likely to continue to decrease.

3 Supplies of fuel oil will be used up in another twenty years.

4 Sulfur dioxide emissions from gaseous fuels will be greater than those from coal in the near future.

3D The data in the table was obtained by estimating the sulfur dioxide emissions from power stations, industrial plants, vehicles, etc.

Sulfur dioxide emissions in the UK could also be monitored by . . .

1 providing each vehicle with a digital readout of sulfur dioxide emitted.

2 measuring the sulfur dioxide concentrations in the air above the largest power stations and industrial plants.

3 measuring the sulfur dioxide concentrations in the air at a large number of sites spread across the UK.

4 measuring the sulfur content of all fuels before they are used.

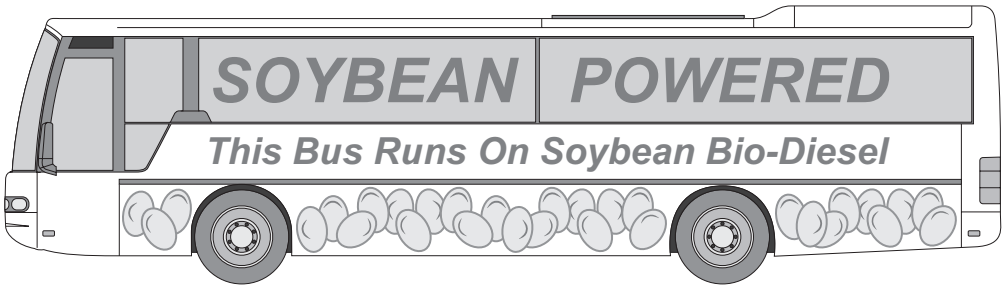
4.9.3.1 Atmospheric pollutants from fuels

Question 07

November 2007 | CHY1B | Original Q9 | Legacy

QUESTION NINE

Petroleum diesel fuel is made from crude oil.
Biodiesel fuel is made from vegetable oils. In America, soybean and rapeseed oil are used.



Biodiesel biodegrades in about a quarter of the time required for petroleum diesel to do so.
Biodiesel, when burned, emits more acidic nitrogen oxides but fewer particulates than petroleum diesel.

Three types of fuel containing biodiesel are available in America:

- B100 (100% biodiesel)
- B20 (20% biodiesel)
- B2 (2% biodiesel).

In a diesel engine, the fuel flows from the fuel tank, along fuel pipes, to the combustion chamber where it is ignited by glow plugs.
There are some operating problems with B100. Biodiesel is much thicker than petroleum diesel and is more difficult to ignite (has a lower cetane number than petroleum diesel). In most engines, the biodiesel needs to be pre-heated.
Biodiesel also has a higher melting point than petroleum diesel and so, in winter, can solidify in pipes and filters.
Using B20 gives few problems, and little or no modification to engines is required.

9A The availability of B2 and B20 may persuade motorists to use biodiesel instead of petroleum diesel.

This could be important because . . .

1 crude oil is non-renewable.

2 biodiesel emissions are less likely to cause acid rain.

3 B100 does not ignite as easily as petroleum diesel.

4 biodiesel does not produce any waste gases when it burns.

Question 07 · continued

9B Ideally, the vegetable oil used for biodiesel should have all these properties **except** . . .

1 a low viscosity.

2 a high melting point.

3 a high cetane number.

4 a good flow rate.

9C Why are **net** carbon dioxide emissions lower for biodiesel than for petroleum diesel?

1 The carbon dioxide is reused to make fossil fuels.

2 Some vegetable oils produce very little carbon dioxide when they burn.

3 The carbon dioxide is recycled as it is used by plants for photosynthesis.

4 The carbon dioxide formed from burning biodiesel is very soluble in water.

9D Spills of fuels from oil tankers cause considerable damage to the marine environment. Spills of biodiesel could be less harmful than those of petroleum diesel.

This is because biodiesel . . .

1 will float more easily on the water.

2 could be burned more easily on the surface of the water.

3 would not spread over the water as easily.

4 would break down into less harmful substances more quickly.

END OF TEST

4.9.3.1 Atmospheric pollutants from fuels

Question 08

January 2008 | CHY1H | Original Q5 | Legacy

5 Since 2000 there has been a lot more research into alternative, environmentally-friendly fuels for road transport.
Several pollutants are found in the exhaust emissions produced when fossil fuels are used for road transport.

Carbon monoxide (CO) interferes with the way that red blood cells carry oxygen.
Carbon dioxide (CO_2) increases the level of carbon dioxide in the atmosphere and causes global warming.

Oxides of nitrogen (NO_x) are produced at high temperatures when nitrogen and oxygen from the atmosphere combine.

Sulfur dioxide (SO_2) is produced when sulfur impurities in the fuel combine with oxygen in the atmosphere.

Tiny particles of solids are produced when the fuel does not burn completely.
This increases the level of particulates (PM10) in the atmosphere.

(a) Name the environmental effect caused by:

(i) oxides of nitrogen (NO_x) and sulfur dioxide (SO_2)

.....

(1 mark)

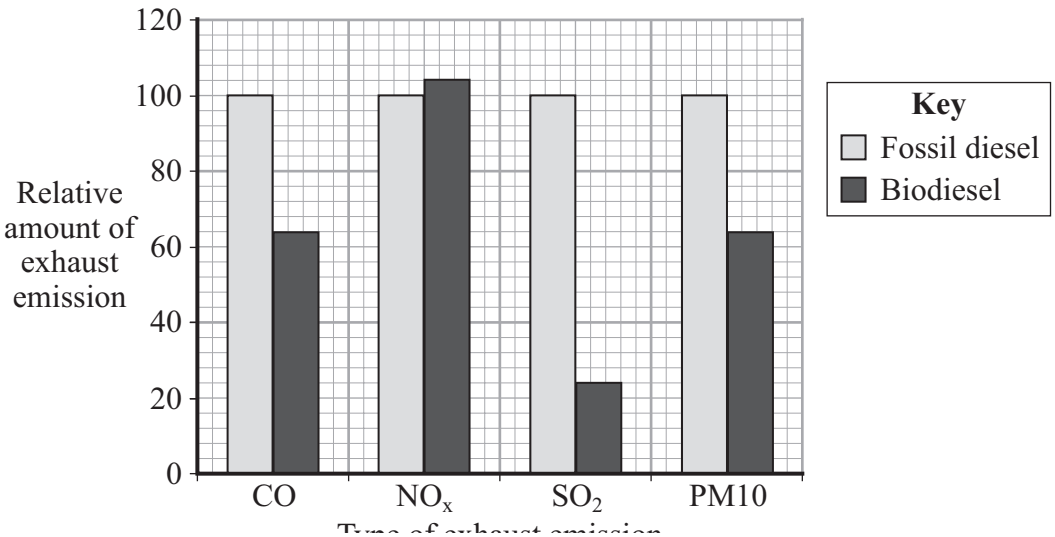
(ii) the increased level of particulates (PM10).

.....

(1 mark)

(b) Diesel obtained from crude oil is often called fossil diesel.
Biodiesel can be made from many vegetable oils.
One research project compared the exhaust emissions when fossil diesel or biodiesel were used as fuels.

Some of the relative amounts of these exhaust emissions are shown in the bar chart.



4.9.3.1 Atmospheric pollutants from fuels

Question 08 · continued

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(i) Use your knowledge and the information opposite to explain the environmental benefits of using biodiesel as a sustainable, low pollution fuel.

.....

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.....

.....

(3 marks)

(ii) Biodiesel is called a green fuel.

This is because the life-cycle emission of carbon dioxide from biodiesel is less than that from fossil diesel.

Use your knowledge and the information opposite to explain why biodiesel's contribution to global warming is considered to be much less than that of fossil diesel.

.....

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.....

.....

(3 marks)

8

4.9.3.1 Atmospheric pollutants from fuels

Question 09

March 2008 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

Scientists have been concerned for some time about the effects of releasing large amounts of sulfur dioxide into the atmosphere. Much of the sulfur dioxide is formed from burning fuels that contain sulfur. The equation for this reaction is:

$$S + O_2 \rightarrow SO_2$$

4A The equation given above for the burning of sulfur is balanced because . . .

1 there are the same number of atoms on each side of the equation.

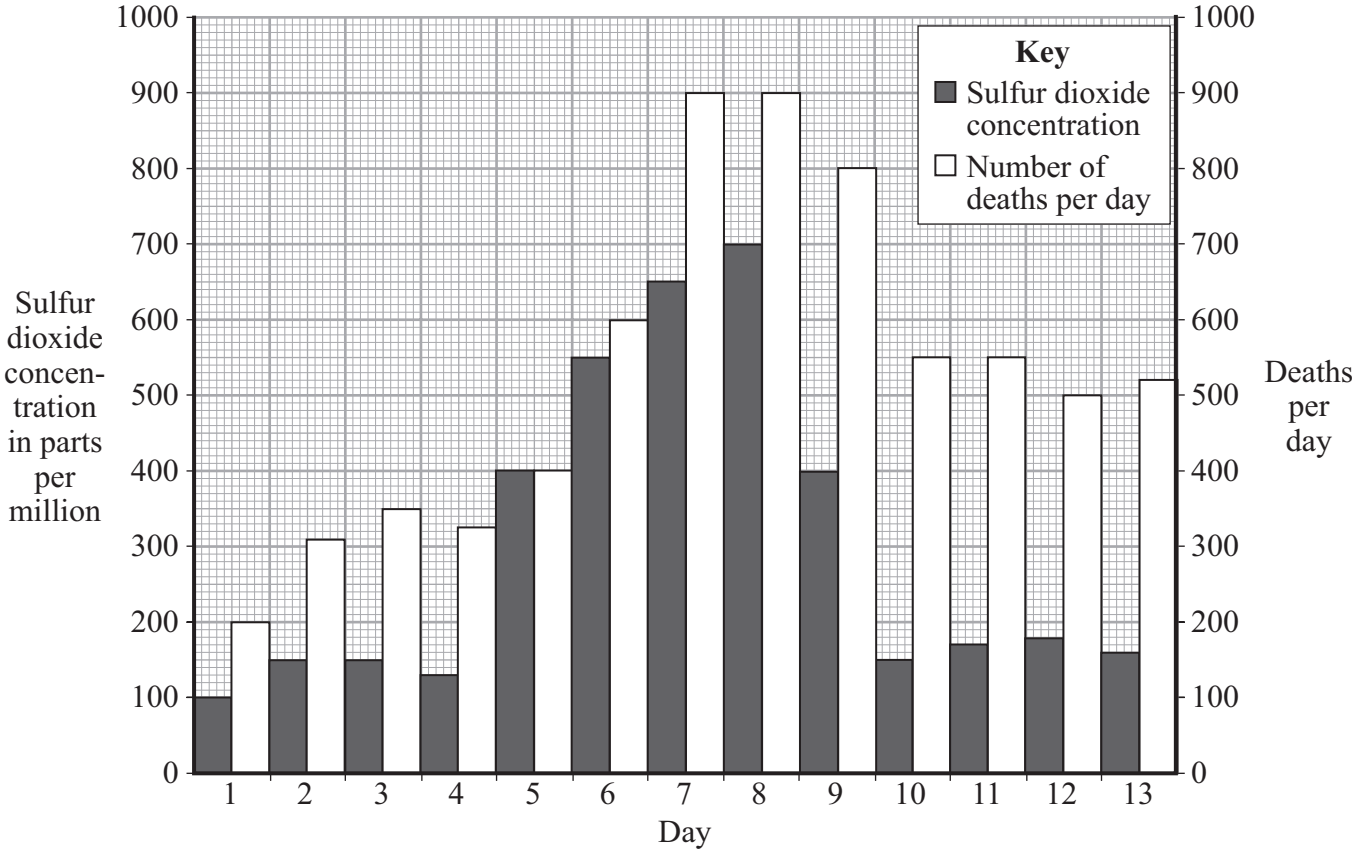
2 there are the same number of each type of atom on each side of the equation.

3 the amount of sulfur dioxide in the air stays about the same.

4 only two elements are involved in the equation.

Some scientists believe that sulfur dioxide is responsible for human deaths. To support this idea, they looked at the death rates during the smogs that occurred in London in the 1950s. The smogs contained sulfur dioxide and smoke particles.

The data the scientists used is shown below.



4.9.3.1 Atmospheric pollutants from fuels

Question 09 · continued March 2008 | CHY1AP | Original Q4 | Legacy

4B The average number of deaths per day from day 5 to day 8 was . . .

1 475

2 700

3 900

4 2800

4C The suggestion that sulfur dioxide in the smog was responsible for human deaths was . . .

1 a conclusion.

2 a hypothesis.

3 a piece of research.

4 a piece of evidence.

4D Which one of the following is a valid statement from the graph?

1 Sulfur dioxide was responsible for the deaths.

2 Smog was responsible for the deaths.

3 Sulfur dioxide could **not** be responsible for the deaths since the graphs do **not** match exactly.

4 Sulfur dioxide was probably responsible for the deaths but other factors may have been responsible.

4.9.3.1 Atmospheric pollutants from fuels

Question 10

March 2008 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The table gives some information about the boiling points and combustion products of the first six alkanes.

			When one molecule of the alkane is completely burned	
Name	**Formula**	**Boiling point in °C**	**Number of molecules of CO_2 formed**	**Number of molecules of H_2O formed**
Methane	CH_4	–168	1	2
Ethane	C_2H_6	– 89	2	3
Propane	C_3H_8	– 42	3	4
Butane	C_4H_{10}	– 0.5		
Pentane	C_5H_{12}	+ 36		
Hexane	C_6H_{14}	+ 69		

8A Which one of the following statements is true about the fractional distillation of a mixture of the alkanes in the table?

1 Each of the fractions collected would contain just **one** alkane.

2 Hexane would be in the fraction selected at the highest temperature.

3 The hottest part of the column would be at the top.

4 Methane would be separated out at the bottom of the column.

8B Which one of the following is true about burning the alkanes?

1 As the size of the alkane molecules increases, the ratio of $CO_2 : H_2O$ molecules formed will eventually be 1:1

2 As the size of the alkane molecules increases, more and more oxygen molecules will be required to completely burn one molecule of the alkane.

3 The amount of water and carbon dioxide formed suggests that the alkanes with larger molecules will ignite more easily.

4 Since only water and carbon dioxide are formed on burning, the alkanes are environmentally-friendly fuels.

4.9.3.1 Atmospheric pollutants from fuels

Question 10 · continued March 2008 | CHY1AP | Original Q8 | Legacy

8C Burning the alkanes that have larger molecules tends to produce carbon monoxide along with carbon dioxide and water.

This suggests that these alkanes . . .

1 do **not** undergo complete combustion.

2 would make better fuels.

3 contain dissolved carbon monoxide gas.

4 can never be made totally pure.

8D To estimate the boiling point of heptane (C_7H_{16}) it would be best to use the boiling points from the table to plot . . .

1 a line graph with the number of carbon atoms as the independent, discrete variable.

2 a line graph with the number of carbon atoms as the categoric variable.

3 a bar chart with the number of carbon atoms as the independent, discrete variable.

4 a bar chart with the number of carbon atoms as the categoric variable.

4.9.3.1 Atmospheric pollutants from fuels

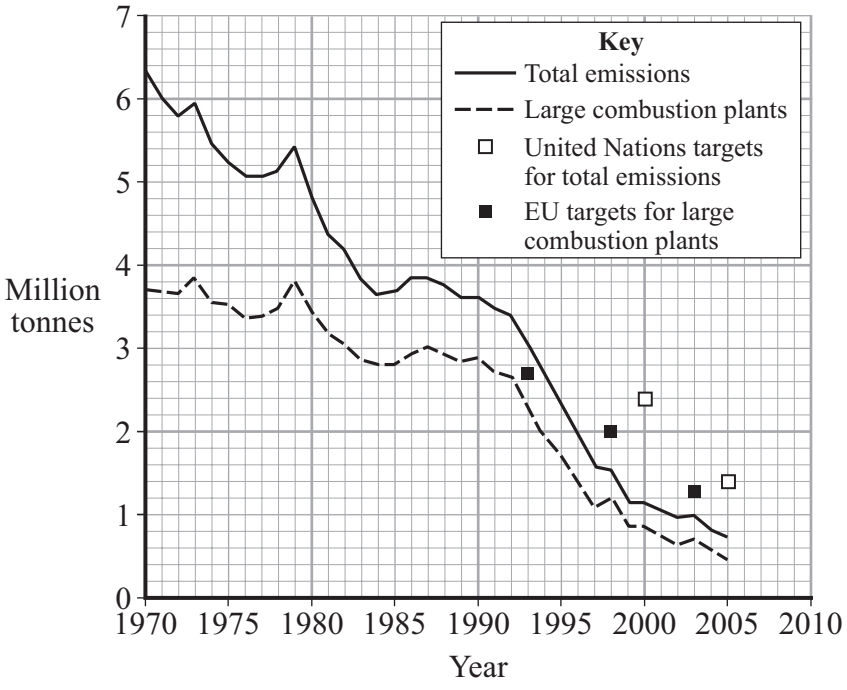
Question 11

March 2008 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

This passage is about sulfur dioxide gas released into the atmosphere in the United Kingdom.

The graph shows sulfur dioxide emissions and also targets set by the European Union and the United Nations.



Large combustion plants are:

- power stations
- oil refineries
- metal refineries
- some manufacturing industries.

Transport, domestic use and services contribute most of the other emissions.

Between 1990 and 2004, the amount of coal used in power stations fell by about 60%; sulfur dioxide emissions from power stations fell by about 82%.

The combustion of petroleum products contributed to 19% of all emissions in 2004, down 77% since 1990. This is mainly due to industry's use of gas rather than oil.

The already small amount of sulfur dioxide emitted from cars and lorries has fallen due to the introduction of ultra-low sulfur petrol and diesel fuels.

4.9.3.1 Atmospheric pollutants from fuels

Question 11 · continued March 2008 | CHY1AP | Original Q9 | Legacy

9A A general conclusion that can be made from the data is that . . .

1 total emissions of sulfur dioxide have fallen every year since 1970.

2 emissions of sulfur dioxide from large combustion plants fell more quickly than total emissions between 1970 and 1990.

3 from 1970 to 1980, total emissions fell by about 1.5 million tonnes.

4 total emissions were greater in 1990 than in 1980.

9B Sulfur dioxide emissions fell quickly from 1990 onwards.

One of the main reasons for this was . . .

1 the use of ultra-low sulfur petrol and diesel fuels.

2 the use of gas instead of oil in industry.

3 the reduction in the use of coal in power stations.

4 the reduction in the use of coal to heat houses.

9C The graph indicates that, of the emission targets set for the United Kingdom . . .

1 all the targets have been reached.

2 only the targets for total emissions have been reached.

3 all except **one** of the targets for emissions from large combustion plants have been reached.

4 none of the targets has been reached.

9D The European Union target for total emissions for the United Kingdom in 2010 is 585 thousand tonnes.

From the evidence in this question, . . .

1 it is probable that this target will be reached.

2 the increasing number of cars will make it difficult to reach this target.

3 it is unlikely that the target will be reached.

4 the target has already been reached.

END OF TEST

4.9.3.1 Atmospheric pollutants from fuels

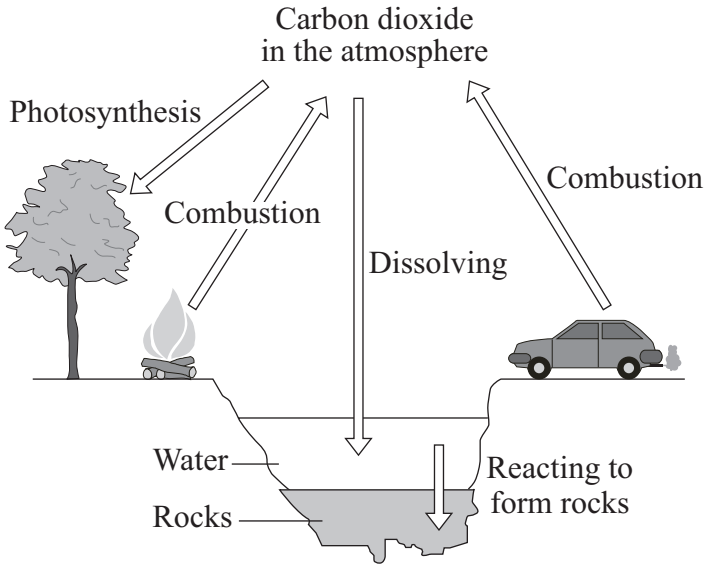
Question 12

March 2008 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

This question is about the balance of carbon dioxide in the atmosphere.

The diagram below shows some of the processes involved in the atmosphere.



The total UK carbon dioxide emissions (million tonnes) from transport between 1990 and 2002 are listed in the table below.

Year	1990	1995	1996	1997	1998	1999	2000	2001	2002
Carbon dioxide emissions in million tonnes	58.5	68.9	75.2	79.7	84.3	84.5	88.3	86.3	86.0

Source: National Statistics website: *www.statistics.gov.uk*
Greenhouse gas emissions from the UK transport industry.
Reproduced under the terms of the Click-Use Licence.

4A The data for total UK carbon dioxide emissions from vehicles could be obtained by . . .

1 measuring the carbon dioxide in the atmosphere.

2 calculating the amount of carbon dioxide produced from the amount of fuel used by vehicles.

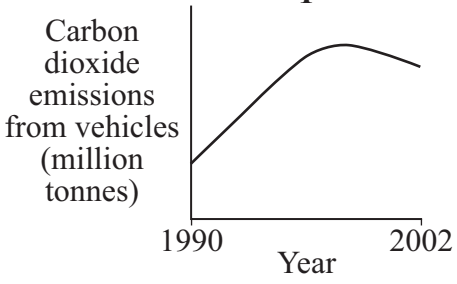
3 counting the number of vehicles on the road.

4 measuring the amount of carbon dioxide in the air near a busy motorway.

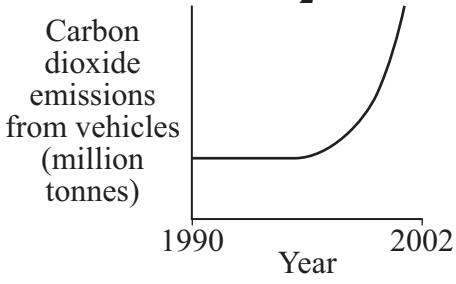
Question 12 · continued

4B A graph plotted using the data 'Year' (x-axis) against 'Carbon dioxide emissions from vehicles' (y-axis) would look like which one of the following?

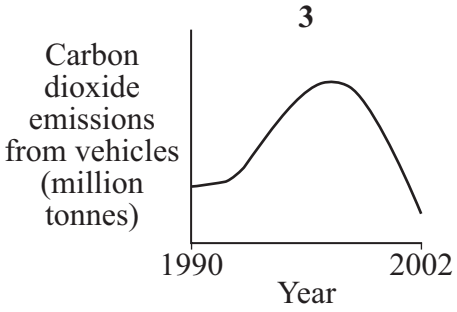
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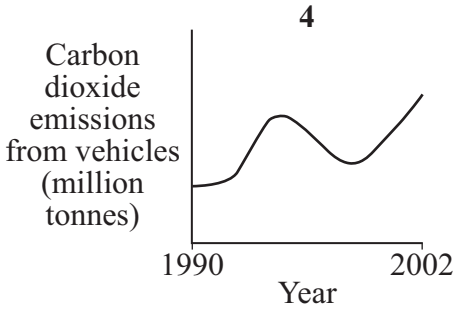
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3



4



4C The increase in the amount of carbon dioxide in the air over the past 40 years is thought to be due mainly to . . .

1 increased growth of plants.

2 increased burning of fossil fuels.

3 the formation of carbonate rocks.

4 the release of carbon dioxide from oceans due to global warming.

4D The amount of carbon dioxide in the atmosphere could be reduced by . . .

1 taking more flights in aeroplanes.

2 cutting down trees in your garden.

3 walking to work instead of using a car.

4 driving a car with a larger engine.

4.9.3.1 Atmospheric pollutants from fuels

Question 13

March 2008 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

This question is about Brazil and its energy reserves available to run cars, and the effect that burning fuels have on the environment.

Brazil is a poor country and is deeply in debt to many nations. It does not have enough oil and coal to meet its needs and importing these fuels is very expensive. It does not produce enough electricity to meet its needs, which makes electricity very expensive in Brazil.

However, Brazil has a massive land area and a favourable climate for growing a large amount of crops such as sugar cane.

The table shows the products formed by burning four different fuels in a car engine.

Fuel	Sulfur dioxide formed	Carbon monoxide formed	Carbon dioxide formed	Water formed
Hydrogen	✗	✗	✗	✓
Ethanol	✗	✗	✓	✓
Syngas	✗	✓	✓	✓
Petrol	✓	✓	✓	✓

8A Which one of the four fuels would produce the least air pollution?

1 hydrogen

2 ethanol

3 syngas

4 petrol

8B Brazil could try to improve its economy and reduce its debt by using cars powered by . . .

1 hydrogen obtained by the electrolysis of water.

2 ethanol obtained from plants.

3 syngas obtained from coal.

4 petrol obtained from crude oil.

4.9.3.1 Atmospheric pollutants from fuels

Question 13 · continued

8C To investigate the possible effects of burning fuels on the temperature of the Earth, it would be best to consult past records giving . . .

1 temperatures accurate to 1 °C over 5 years.

2 temperatures accurate to 1 °C over 50 years.

3 temperatures accurate to 0.1 °C over 5 years.

4 temperatures accurate to 0.1 °C over 50 years.

8D To assess the evidence about fuels, it would be best to consult scientists . . .

1 employed by car manufacturers.

2 employed by farmers.

3 employed by oil companies.

4 employed by universities.

4.9.3.1 Atmospheric pollutants from fuels

Question 14

June 2008 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

The flow chart below gives information about some of the substances involved in the combustion of a hydrocarbon fuel.

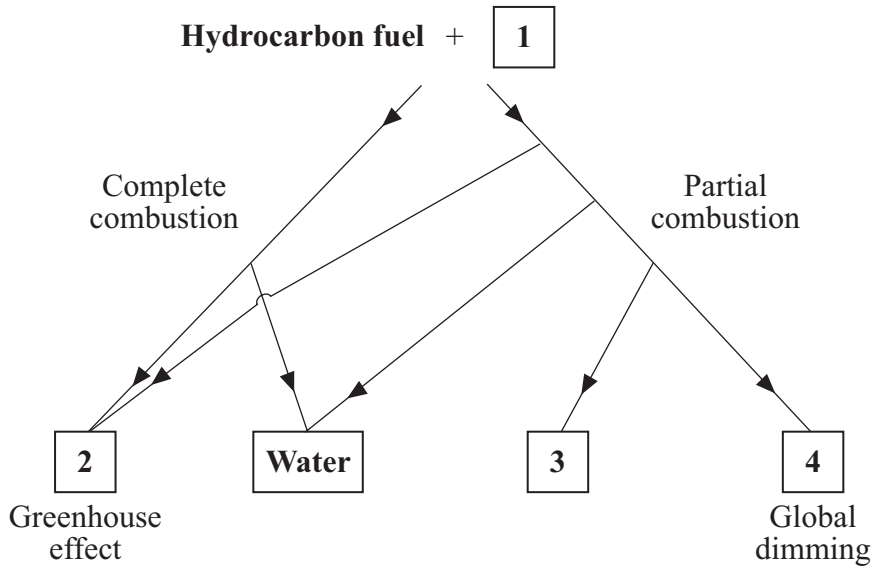
Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the flow chart.

A carbon monoxide

B carbon particles

C oxygen

D carbon dioxide



4.9.3.1 Atmospheric pollutants from fuels

Question 15

June 2008 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

Scientists are researching new catalysts to convert compounds in coal into small hydrocarbon molecules.

These small molecules can be used to make liquid fuels such as petrol.

4A Scientists are trying to develop processes that convert coal into liquid fuels, such as petrol, because . . .

1 they have found new supplies of catalysts.

2 oil reserves are running out quickly.

3 there is no alternative to using coal.

4 catalysts are being used up.

4B Petrol is made from small molecules and **not** large molecules because hydrocarbons with small molecules . . .

1 have a higher boiling point.

2 are more viscous.

3 are darker in colour.

4 ignite more easily.

4C Both petrol and coal produce carbon dioxide when burned.

To compare the volume of the gas produced by a sample of coal with the volume of gas produced by a sample of petrol, a control variable would be . . .

1 how much carbon dioxide is produced.

2 the amount of coal and petrol used.

3 the speed at which each fuel is set alight.

4 the time taken to burn all the fuel.

4.9.3.1 Atmospheric pollutants from fuels

Question 15 · continued

4D Ethanol, made from plant material, is another liquid fuel used in cars.

Ethanol and petrol produce similar amounts of carbon dioxide when they burn.

Burning ethanol made from plant material, in cars, is thought to be less of an environmental problem than burning petrol.

This is because . . .

1 ethanol does **not** produce water when it burns.

2 using ethanol made from plants as a fuel does **not** change the amount of carbon dioxide in the atmosphere.

3 ethanol will burn without using oxygen.

4 in the car engine, only partial combustion of the ethanol occurs.

Turn over for the next question

4.9.3.1 Atmospheric pollutants from fuels

Question 16

June 2008 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

Environmentalists say that the introduction of low-sulfur fuels is essential because it gives cleaner emissions from vehicles.

Scientists disagree about the emissions of carbon dioxide from low-sulfur fuels.
Some claim that low-sulfur fuels give higher emissions of carbon dioxide.
Other scientists suggest that the improved fuel consumption from these fuels means that less carbon dioxide is released.

5A Vehicle emissions would be cleaner using low-sulfur fuels because they would **definitely** produce less . . .

1 carbon dioxide.

2 carbon monoxide.

3 nitrogen oxides.

4 sulfur dioxide.

5B Scientists disagree about the emissions of carbon dioxide from low-sulfur fuels because . . .

1 they **cannot** repeat the results of their investigation.

2 simple experiments do **not** give accurate results.

3 there are **not** enough variables in their investigations.

4 the data they are using is too simple for a complex problem.

Oil companies are concerned about the cost of removing more sulfur from fuels. They claim that more dinitrogen oxide (N_2O) is produced by these fuels when catalytic converters are running at low temperatures. Dinitrogen oxide is 310 times more powerful than carbon dioxide as a greenhouse gas.

5C Oil companies do **not** want to remove more sulfur from fuels because . . .

1 increased production costs would put up the price of their fuels.

2 they would sell less fuel because of improved fuel consumption.

3 they do **not** agree that the emissions from low-sulfur fuels are cleaner.

4 customers do **not** believe that the fuels are any better for the environment.

4.9.3.1 Atmospheric pollutants from fuels

Question 16 · continued

5D The oil companies claim that more dinitrogen oxide is produced when low-sulfur fuels are used.

How could this be verified?

1 The oil companies should repeat their investigations.

2 Independent scientists should carry out further investigations.

3 Government scientists should measure the levels of dinitrogen oxide near motorways.

4 University students should research the effects of dinitrogen oxide when it is released into the atmosphere.

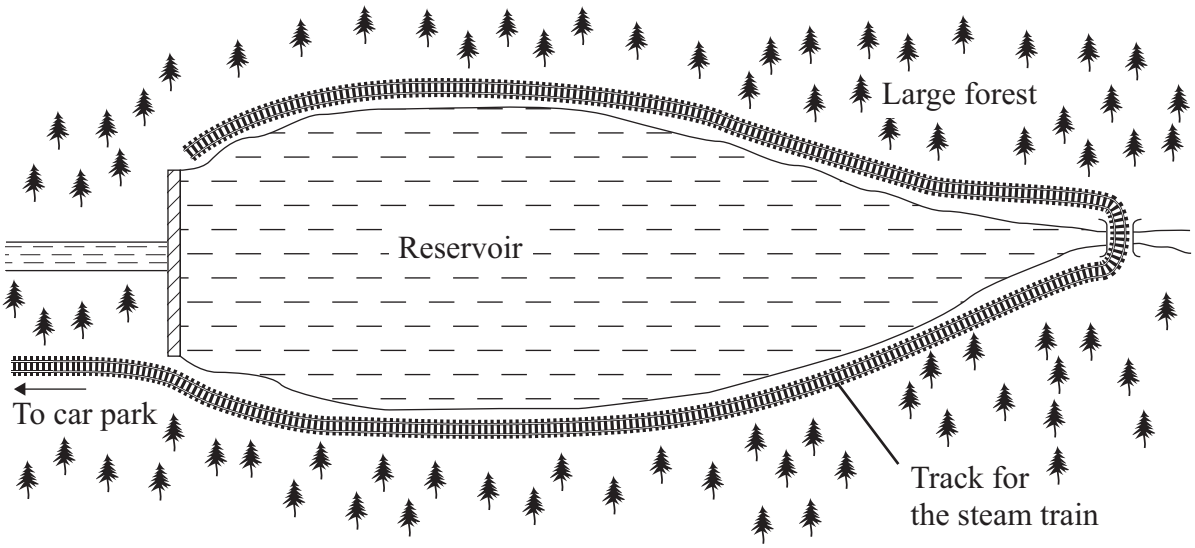
Turn over for the next question

4.9.3.1 Atmospheric pollutants from fuels

Question 17

June 2008 | CHY1H | Original Q6 | Legacy

6 A large reservoir is surrounded by trees. Planners need to protect the environment. The distance around the reservoir is many kilometres. There will be only one road access to a car park a few kilometres from the reservoir. From the car park people would be transported to accommodation, activities or places of interest by steam train.



6 (a) Coal contains carbon and small amounts of sulfur. The steam train would cause environmental problems if coal were used as the fuel.

Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 17 · continued

for mark

6 (b) The planners have stated that, as a result of using the steam train, there must be no overall increase of carbon dioxide added to the atmosphere. The steam train would be considered as 'carbon neutral' if wood, from the surrounding forest, were used as the fuel.

Suggest why.

.....

.....

.....

.....

.....

.....

(3 marks)

7

Turn over for the next question

4.9.3.1 Atmospheric pollutants from fuels

Question 18

November 2008 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

Hydrocarbon fuels, **K**, **L**, **M** and **N**, were burned and the products were collected and identified.

The results are shown in the table below.

	Hydrocarbon fuels			
Products of burning	**K**	**L**	**M**	**N**
Carbon monoxide	✓	✓	✓	✗
Carbon dioxide	✓	✓	✓	✓
Water vapour	✓	✓	✓	✓
Soot	✓	✓	✗	✗
Sulfur dioxide	✗	✗	✓	✓

Key:
✓ indicates that the substance is one of the products
✗ indicates that the substance is **not** one of the products.

3A The results show that combustion was **only** complete for . . .

1 hydrocarbon fuel **K**.

2 hydrocarbon fuel **L**.

3 hydrocarbon fuel **M**.

4 hydrocarbon fuel **N**.

4.9.3.1 Atmospheric pollutants from fuels

Question 18 · continued November 2008 | CHY1AP | Original Q3 | Legacy

3B The table of results shows that the hydrocarbon fuels that do **not** contain sulfur are . . .

1 **M** and **N**.

2 **K** and **L**.

3 **L** and **M**.

4 **K** and **M**.

3C When hydrocarbon fuels are burned, some of the products cause problems.

Which one of the following statements correctly describes a problem that is caused by the products of burning?

1 Sulfur dioxide in the air causes heavier rainfall.

2 Releasing large amounts of carbon dioxide into the atmosphere produces ‘acid rain’.

3 A build-up of particles in the air causes ‘global dimming’.

4 Releasing large amounts of carbon dioxide into the atmosphere causes ‘global dimming’.

3D Ethanol is a compound of carbon, hydrogen and oxygen.
Ethanol can be used as a fuel in vehicles together with, or in place of, hydrocarbon fuels.

An advantage of ethanol as a fuel is that when it burns . . .

1 no carbon dioxide is produced.

2 carbon dioxide and water are produced.

3 no sulfur dioxide is produced.

4 only water is produced.

4.9.3.1 Atmospheric pollutants from fuels

Question 19

November 2008 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

Environmentalists say that the use of low-sulfur fuels is essential.
It is claimed that high sulfur dioxide levels in the air cause health problems such as asthma.

The table shows the number of deaths from asthma in five age groups from 1960 to 1995.

Year	Number of deaths from asthma for each age group				
	0–14	15–44	45–64	65–84	85 and above
1960	50	250	750	1230	1240
1965	100	700	1500	2030	2040
1970	50	250	700	1210	1230
1975	40	200	600	1180	1200
1980	40	200	660	1400	1450
1985	40	250	900	1770	1900
1990	30	200	650	1650	1800
1995	30	150	520	1200	1370
2000					

Sources:
ONS: *www.statistics.gov.uk* Reproduced under the terms of the Click-Use Licence.
Lung and Asthma Information Agency, St. Georges University of London: *www.laia.co.uk*

5A Which one of the following statements is true about deaths from asthma?

1 Values for all age groups increased and then decreased without a further increase.

2 The largest range of deaths occurred in the 0–14 age group.

3 Values for each age group peaked in 1965.

4 The values for each year always increased for any given age group.

Question 19 · continued

5B Which row in the table most accurately shows the expected deaths in Year 2000 if the trend from 1985 to 1995 continued?

	0–14	15–44	45–64	65–84	85 and above
1	30	100	460	950	1000
2	50	100	310	1250	1500
3	70	180	720	950	1000
4	30	150	520	1300	1400

5C A doctor has noticed an increase in cases of asthma in his patients. He thinks it may be linked to the release of sulfur dioxide into the atmosphere from cars following the recent building of a new road near his surgery. He decides to carry out a survey to test his hypothesis.

The best people to survey would be all his patients who . . .

1 drive and have breathing problems.

2 live near the new road.

3 are over 65 years old.

4 drive to work.

5D An improvement that the use of low-sulfur fuels should bring is . . .

1 less acid gas entering the atmosphere.

2 a reduction in carbon emissions.

3 a reduction in carbon monoxide emissions.

4 less nitrogen entering the atmosphere.

4.9.3.1 Atmospheric pollutants from fuels

Question 20

November 2008 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

Benzene is a chemical which used to be obtained from whale oil. It is now mainly manufactured from crude oil, but it can also be obtained from coal. It is an extremely useful substance in the chemical industry, but it is very toxic. The chemical formula for benzene is C_6H_6

9A Which of the following statements about benzene is true?

1 It is a hydrocarbon.

2 It is an alkane.

3 It is a mixture.

4 It is safe to use as a fuel.

9B The equation below for the combustion of benzene is **not** balanced.

$$2C_6H_6 \quad + \quad \ldots\ldots O_2 \quad \rightarrow \quad 12CO_2 \quad + \quad 6H_2O$$

How many oxygen molecules would be required to balance the equation?

1 12

2 15

3 18

4 30

9C Benzene burns with a very smoky flame, producing lots of soot.

This is because . . .

1 it is manufactured from crude oil.

2 it has very large molecules.

3 it has a high ratio of carbon to hydrogen atoms.

4 it is very toxic.

9D The price of benzene is increasing.

This could be because . . .

1 whales are harder to catch.

2 there is no demand for benzene.

3 it is obtained from a renewable resource.

4 the costs of crude oil and coal are rising.

END OF TEST

4.9.3.1 Atmospheric pollutants from fuels

Question 21

November 2008 | CHY1BP | Original Q6 | Legacy

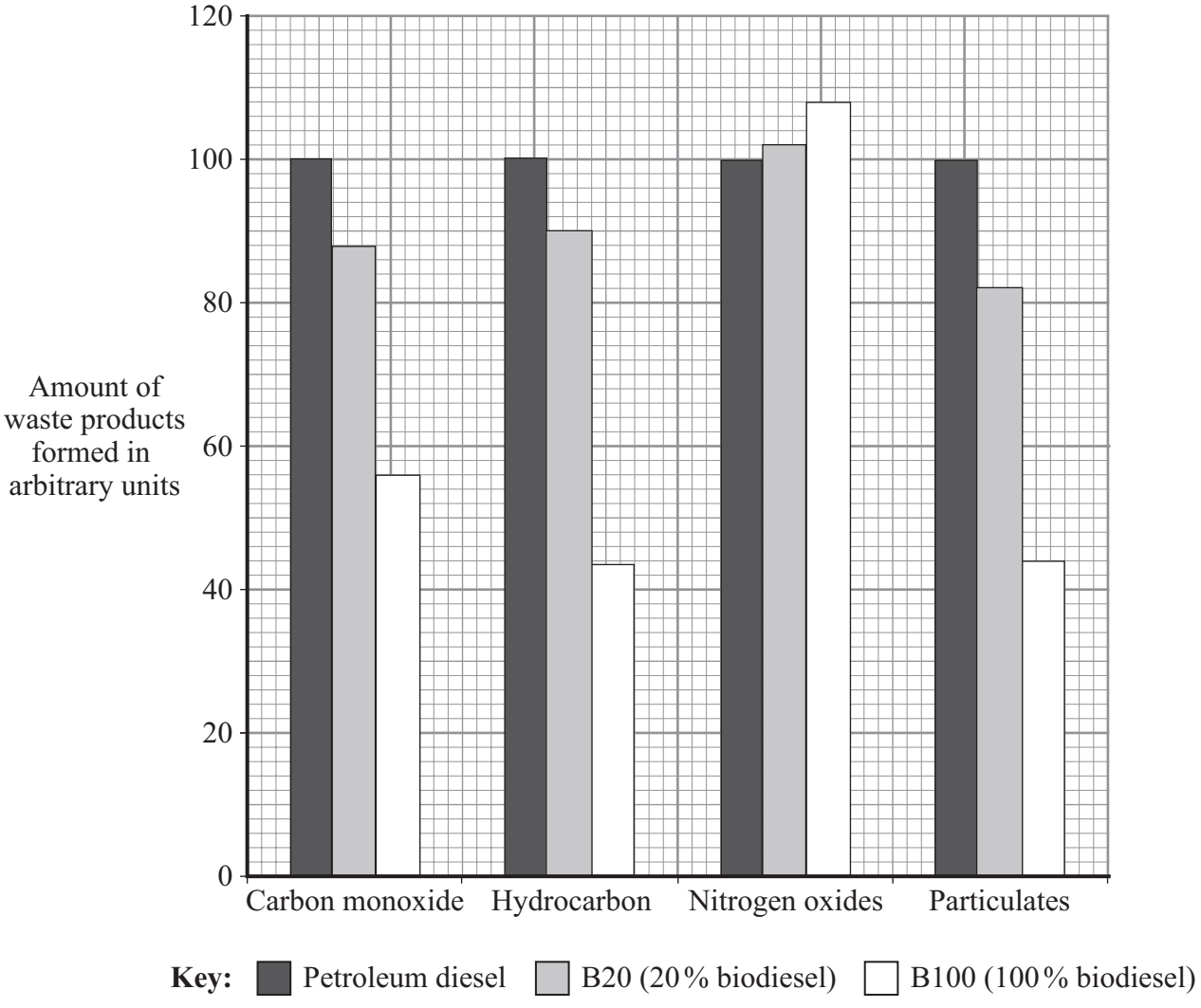
QUESTION SIX

Biodiesel is a fuel made from vegetable oils. It can be mixed with or it can entirely replace petroleum diesel fuel in vehicles.
B20 is petroleum diesel with 20 % biodiesel.
B100 is 100 % biodiesel.

Petroleum diesel is made from crude oil.

In a car engine, the fuel ignites and burns in air. The waste products formed leave the engine through the exhaust system.

The bar graph compares the quantities of four different waste products formed by burning B20 and B100 with the quantities formed by burning petroleum diesel.



Question 21 · continued November 2008 | CHY1BP | Original Q6 | Legacy

6A From the information on the chart, the use of B100 instead of B20 will reduce particulates by about . . .

1 5 times.

2 half.

3 20%

4 35%

6B Which of the following is a correct statement about the waste products formed by burning these fuels?

1 They are all oxides.

2 They are all reduced when B20 is used instead of petroleum diesel.

3 Water vapour is also produced.

4 No carbon dioxide is produced with B100.

6C The main advantage of B100 over petroleum diesel is that B100 . . .

1 is non-biodegradable.

2 is renewable.

3 is unsaturated.

4 is hydrogenated.

6D Why are net carbon dioxide emissions lower for biodiesel than for petroleum diesel?

1 Plants use carbon dioxide for photosynthesis.

2 There are fewer alkanes in biodiesel.

3 Biodiesel does **not** contain any hydrocarbons.

4 Plants produce carbon dioxide in respiration.

4.9.3.1 Atmospheric pollutants from fuels

Question 22

March 2009 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

Fuels burn in air to form oxides of the elements they contain.
When fuel molecules contain a large number of carbon atoms, combustion is not always complete.
With incomplete combustion, carbon particles may be produced.

Match molecules, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A H_2

B CO

C C_4H_{10}

D $C_{14}H_{28}$

1	It will burn to form carbon dioxide only.
2	It will burn to form water only.
3	It is an alkane.
4	It will probably contribute to global dimming when burned.

4.9.3.1 Atmospheric pollutants from fuels

Question 23

June 2009 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

This question is about substances that can be burned in air.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A C_2H_5SH

B C_2H_6

C C_2H_2

D C

1	It would contribute to the formation of acid rain when burned.
2	It is an alkane.
3	It corresponds to the general formula C_nH_{2n-2}
4	It forms only carbon dioxide when burned in air.

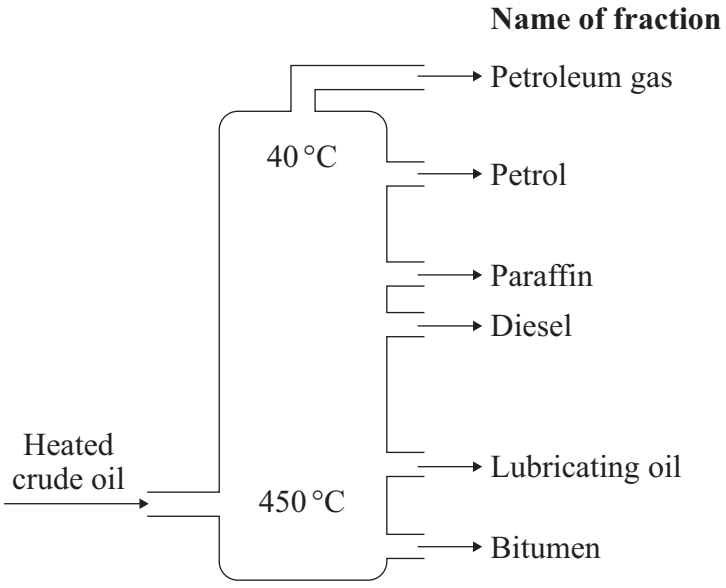
4.9.3.1 Atmospheric pollutants from fuels

Question 24

June 2009 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

In a fractionating column, crude oil is separated into a number of fractions.



5A The crude oil separates into fractions in the fractionating column because . . .

1 it changes from a liquid to a vapour.

2 crude oil vapour condenses at 100 °C.

3 crude oil vapour condenses at different temperatures.

4 decomposition of the crude oil occurs.

5B The diesel fraction boils over a range of temperatures from about 250 °C to 340 °C.

The fraction does **not** have a fixed boiling point because . . .

1 the temperature in the fractionating column is **not** constant.

2 the hydrocarbons in the fraction have different chemical properties.

3 the fraction contains a mixture of hydrocarbons.

4 liquid hydrocarbons boil at temperatures above 250 °C.

4.9.3.1 Atmospheric pollutants from fuels

Question 24 · continued June 2009 | CHY1AP | Original Q5 | Legacy

5C The hydrocarbons from the bitumen fraction will . . .

1 be difficult to ignite at room temperature.

2 have small molecules.

3 be gases or liquids at room temperature.

4 have a small number of carbon atoms in each molecule.

5D A hydrocarbon from the lubricating oil fraction burns, in air, with a smoky flame.

This suggests that . . .

1 the hydrocarbon contains sulfur as an impurity.

2 there is only partial combustion of the hydrocarbon.

3 the hydrocarbon has small molecules.

4 when the hydrocarbon burns, it is oxidised.

4.9.3.1 Atmospheric pollutants from fuels

Question 25

June 2009 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Two problems caused by the gases released when fossil fuels are burned are:

- acid rain, caused by sulfur dioxide and oxides of nitrogen
- global warming, caused by carbon dioxide.

Fuel manufacturers have introduced low-sulfur fuels to try to reduce the sulfur dioxide emissions.

6A Low-sulfur fuels were introduced in the UK in 2000. The amount of acid rain gases from transport increased from 2000 to 2004.

This increase could be due to . . .

1 the partial combustion of low-sulfur fuels.

2 an increasing number of vehicles on the UK's roads.

3 increasing emissions of carbon monoxide.

4 some sulfur dioxide not dissolving in rain water.

6B Carbon monoxide and oxides of nitrogen can be removed by a catalytic converter in the exhaust system of vehicles. The two gases, carbon monoxide (CO) and nitrogen dioxide (NO_2), react to produce carbon dioxide (CO_2) and nitrogen (N_2).

The balanced equation that correctly describes this reaction is . . .

1 $CO + NO_2 \rightarrow CO_2 + N_2$

2 $2CO + NO_2 \rightarrow 2CO_2 + N_2$

3 $3CO + 2NO_2 \rightarrow 3CO_2 + N_2$

4 $4CO + 2NO_2 \rightarrow 4CO_2 + N_2$

6C The conversion of carbon monoxide and nitrogen dioxide to carbon dioxide and nitrogen will . . .

1 decrease acid rain and decrease global warming.

2 decrease acid rain and increase global warming.

3 increase acid rain and increase global warming.

4 increase acid rain and decrease global warming.

4.9.3.1 Atmospheric pollutants from fuels

Question 25 · continued

6D Environmentalists have encouraged the use of hydrogen as a fuel instead of petrol because . . .

1 hydrogen is a renewable fuel obtained from sugar.

2 carbon monoxide is the main product of combustion.

3 no carbon dioxide is produced when hydrogen is burned.

4 hydrogen produces only low levels of sulfur dioxide when burned.

Turn over for the next question

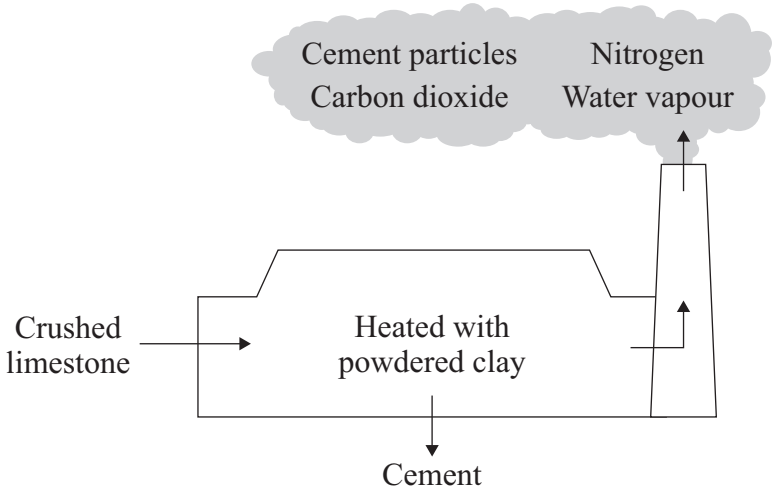
4.9.3.1 Atmospheric pollutants from fuels

Question 26

June 2009 | CHY1H | Original Q1 | Legacy

1 A limestone quarry is in an area of natural beauty and near several villages.
The company operating the quarry wants planning permission to build a new cement works in the quarry.

The diagram shows some of the substances used and produced at a cement works.



1 (a) Limestone is mainly calcium carbonate, $CaCO_3$.
Write the correct number in the box to complete each sentence.

1 (a) (i) The formula shows that calcium carbonate, $CaCO_3$,

contains ☐ different elements.

(1 mark)

1 (a) (ii) Calcium carbonate, $CaCO_3$, contains a total number of ☐ atoms.

(1 mark)

4.9.3.1 Atmospheric pollutants from fuels

Question 26 · continued

for mark

1 (b) The company wants the new cement works because the nearest cement works is 100 km from the quarry. The company argues that a new cement works sited inside the quarry would reduce carbon dioxide emissions.

Suggest why the new cement works might reduce carbon dioxide emissions.

.....

.....

.....

(1 mark)

1 (c) Residents from the villages near the quarry are concerned that there will be atmospheric pollution from the new cement works.

1 (c) (i) Name and explain how **one** of the emissions from the chimney causes atmospheric pollution.

Name of emission: .....

Explanation: .....

.....

(2 marks)

1 (c) (ii) Suggest what the company could do to reduce this atmospheric pollution.

.....

.....

(1 mark)

6

4.9.3.1 Atmospheric pollutants from fuels

Question 27

November 2009 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about four chemical substances involved in the two chemical reactions below.

$$ZnCO_3 \rightarrow ZnO + \text{Substance } \mathbf{X}$$

$$2ZnO + C \rightarrow 2Zn + \text{Substance } \mathbf{X}$$

Match formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A $ZnCO_3$

B C

C CO_2

D ZnO

1	It is the metal oxide produced by thermal decomposition.
2	It has a formula made up of five atoms of three different elements.
3	It is the compound produced in both reactions.
4	It will burn in a limited supply of air to produce carbon monoxide and carbon dioxide.

4.9.3.1 Atmospheric pollutants from fuels

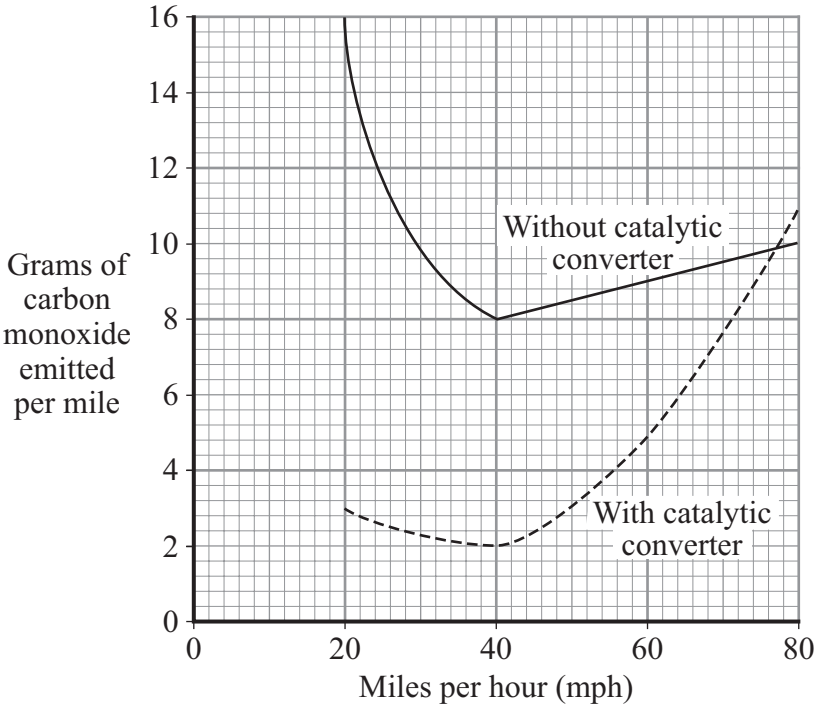
Question 28

November 2009 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Catalytic converters are fitted to car exhausts to reduce harmful emissions from the car.
In a catalytic converter, carbon monoxide is converted into carbon dioxide. However, catalytic converters are not 100 % efficient.

The graph shows the effect of a catalytic converter.



6A At 40 mph, a catalytic converter reduces carbon monoxide emissions by . . .

1 2 g per mile.

2 4 g per mile.

3 6 g per mile.

4 8 g per mile.

4.9.3.1 Atmospheric pollutants from fuels

Question 28 · continued

6B At what speed does a car with a catalytic converter emit the same amount of carbon monoxide as a car without a catalytic converter?

1 40 mph

2 70 mph

3 77 mph

4 80 mph

6C Which statement about the graph is true?

1 Catalytic converters work best at speeds above 40 mph.

2 The higher the speed, the higher the carbon monoxide emissions.

3 There is no connection between speed and the amount of carbon monoxide emitted.

4 Catalytic converters are more effective at lower speeds.

6D All the carbon monoxide emitted into the atmosphere eventually forms carbon dioxide.

Which of the following statements is true?

1 Using catalytic converters reduces the amount of carbon dioxide put into the atmosphere by cars.

2 The effect that car emissions have on global warming is not changed by using catalytic converters.

3 Carbon dioxide levels are not affected by the use of cars.

4 A car without a catalytic converter produces more carbon dioxide than a car fitted with one.

4.9.3.1 Atmospheric pollutants from fuels

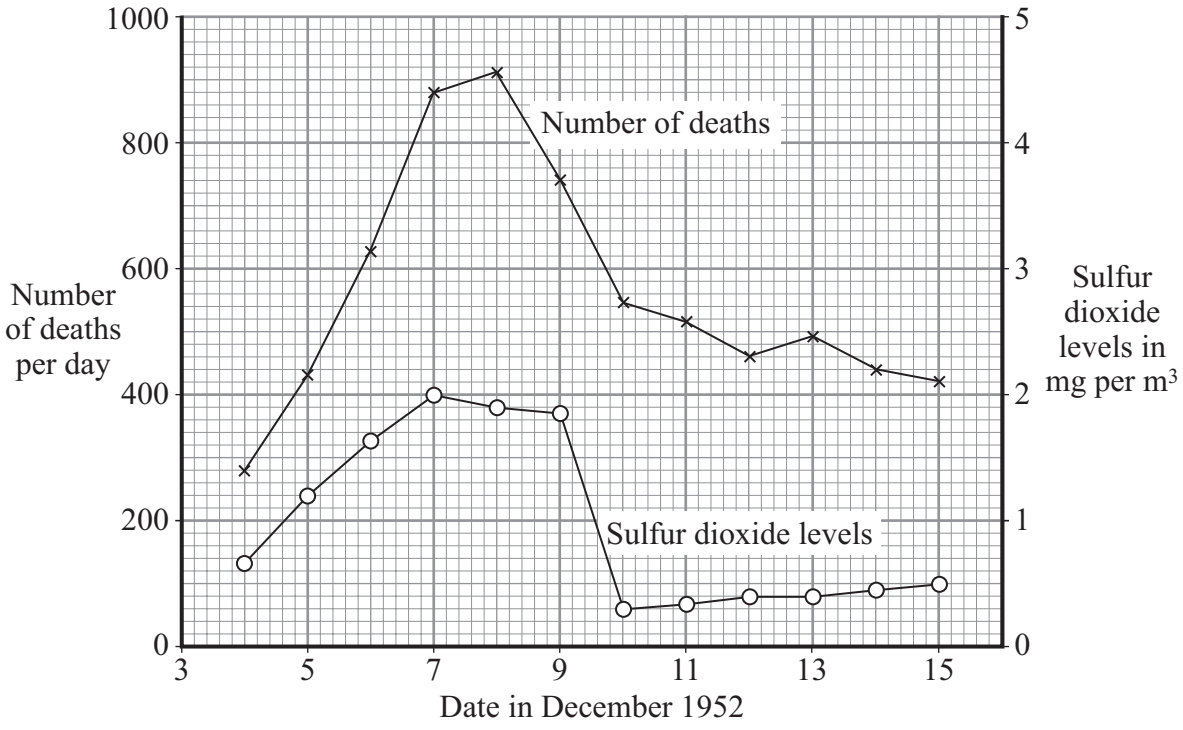
Question 29

November 2009 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

Smog is a mixture containing sulfur dioxide and smoke particles.

The graph below shows how the number of deaths due to sulfur dioxide varied during the Great Smog in London during December 1952.



7A It is generally agreed that sulfur dioxide caused the increase in the number of deaths in London in December 1952.

Which of the following would be the best argument **against** this conclusion?

1 The level of sulfur dioxide does **not** go as high as the number of deaths.

2 After a period of time, the sulfur dioxide levels increase but the number of deaths decreases.

3 The graphs show a similar pattern of increase and decrease.

4 The number of deaths increases faster than the sulfur dioxide levels increase.

Question 29 · continued November 2009 | CHY1AP | Original Q7 | Legacy

7B A group of students studying the Great Smog of London in 1952 wrote four statements after looking at the data.

Which one of their statements is correct?

1 The number of deaths peaks on the same day as sulfur dioxide levels peak.

2 The number of deaths always increases when sulfur dioxide levels increase.

3 On the day that sulfur dioxide levels reached 2 mg per m^3, there were 880 deaths.

4 If sulfur dioxide levels double, the number of deaths doubles.

7C Many cars now use low-sulfur fuels that were introduced in 2000. However, the amount of sulfur dioxide emissions from vehicles in the UK has increased since 2000.

This increase is because . . .

1 early versions of low-sulfur fuels did not burn correctly.

2 there is an increasing number of vehicles on UK roads.

3 there is now 5 % ethanol (C_2H_5OH) in petrol.

4 sulfur dioxide is producing acid rain.

7D Sulfur dioxide can be removed from the waste gases from power stations using a process called flue gas desulfurisation. This is done by reacting the sulfur dioxide [SO_2] with calcium carbonate [$CaCO_3$], calcium oxide [CaO], calcium hydroxide [$Ca(OH)_2$] or magnesium oxide [MgO].

Which one of the following is **not** a correctly balanced equation for a reaction taking place during *flue gas desulfurisation*?

1 $SO_2 + MgO \rightarrow MgSO_3$

2 $SO_2 + CaO \rightarrow CaSO_3$

3 $SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2$

4 $SO_2 + Ca(OH)_2 \rightarrow CaSO_3 + 2H_2O$

4.9.3.1 Atmospheric pollutants from fuels

Question 30

November 2009 | CHY1BP | Original Q9 | Legacy

QUESTION NINE

Some scientists think that the Earth's early atmosphere was mainly carbon dioxide, water vapour and nitrogen, with no oxygen.

Some scientists think that the early atmosphere also contained carbon monoxide, hydrogen, methane and ammonia.

Other scientists think that the atmosphere has always contained some oxygen.

Evidence comes from geological records starting over 4 billion years ago, the composition of gases from volcanoes, observations of conditions on other planets, and the composition of the atmosphere today.

The table shows some information about the atmospheres of the planets, Venus, Earth and Mars today.

	Venus	**Earth**	**Mars**
Carbon dioxide, % by mass	98.0	0.036	95.0
Oxygen, % by mass	0.0	21.0	0.25
Nitrogen, % by mass	2.0	78.0	2.4
Water vapour, % by mass	0.05	0.20	0.10
Mass of atmosphere in tonnes	5.2×10^{17}	5.2×10^{15}	2.4×10^{10}

9A Scientists do **not** agree about the Earth's early atmosphere because . . .

1 there is too much evidence available.

2 the information can be interpreted in different ways.

3 the data is inaccurate.

4 geological records do not go back far enough.

9B Which of the following supports the idea that there was oxygen in the Earth's early atmosphere?

1 Calcium sulfate ($CaSO_4$) is found in rocks formed 3.5 billion years ago.

2 Many of the oldest rocks contain iron sulfide, FeS.

3 The atmosphere now contains more than 20% oxygen.

4 Some of the gases in the early atmosphere came from volcanoes.

4.9.3.1 Atmospheric pollutants from fuels

Question 30 · continued

9C Which one of these is an **incorrect** reason for the small percentage of carbon dioxide in the Earth's atmosphere today?

1 Some carbon dioxide has dissolved in the oceans.

2 Carbon dioxide has been used in chemical reactions to form sedimentary rocks.

3 Some carbon dioxide has been locked up in fossil fuels.

4 There has always been only a small amount of carbon dioxide in the atmosphere.

9D Which one of the following statements is true?

1 Venus has the smallest mass of water vapour in its atmosphere.

2 Earth has a greater mass of water vapour in its atmosphere than Venus or Mars.

3 Venus has a greater mass of nitrogen in its atmosphere than Earth or Mars.

4 Mars has a greater mass of carbon dioxide in its atmosphere than the Earth.

END OF TEST

4.9.3.1 Atmospheric pollutants from fuels

Question 31

January 2010 | CHY3H | Original Q6 | Legacy

6 During a thunderstorm lightning strikes the Eiffel Tower.

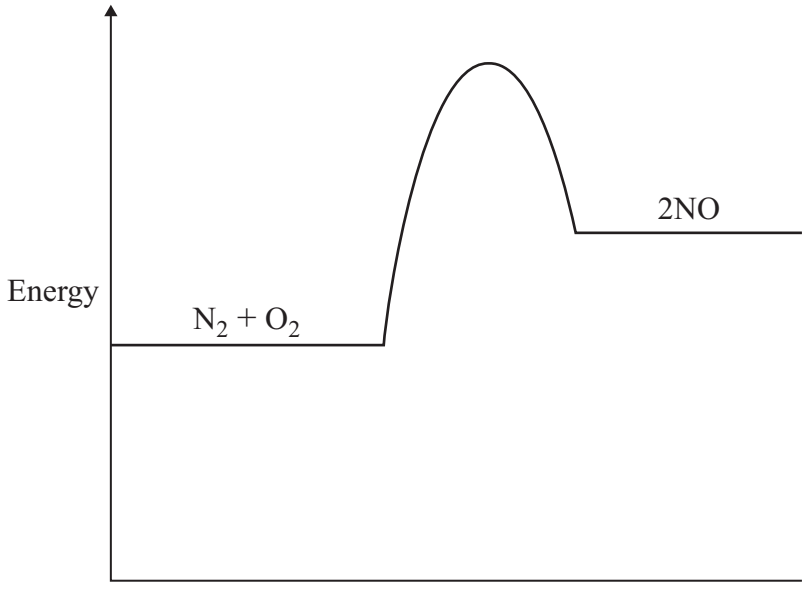


In lightning the temperature can reach 30 000 °C. This causes nitrogen and oxygen in the air to react, producing nitrogen oxide. This reaction has a high *activation energy* and is *endothermic*.

An equation that represents this endothermic reaction is:

$$N_2 + O_2 \rightarrow 2NO$$

The energy level diagram for this reaction is given below.



6 (a) The energy level diagram shows that this reaction is *endothermic*.

Explain how.

.....

.....

(1 mark)

4.9.3.1 Atmospheric pollutants from fuels

Question 31 · continued

for mark

6 (b) What is meant by the term *activation energy*?

.....

.....

(1 mark)

6 (c) The equation showing the structural formulae of the reactants and products is

$$N \equiv N \quad + \quad O = O \quad \rightarrow \quad 2\ N = O$$

Bond	Bond energy in kJ
N ≡ N	945
O = O	498
N = O	630

6 (c) (i) Use the bond energies in the table to calculate the energy change for this reaction.

.....

.....

.....

.....

Energy change = ... kJ

(3 marks)

6 (c) (ii) In terms of bond energies, explain why this reaction is endothermic.

.....

.....

.....

(1 mark)

6

4.9.3.1 Atmospheric pollutants from fuels

Question 32

March 2010 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

Fuel oil is a mixture of compounds, mainly hydrocarbons.

Fuel oil is obtained from crude oil by fractional distillation.

5A Which of the following hydrocarbons is an alkane?

1 CH_6

2 C_3H_6

3 C_2H_6

4 C_2H_4

5B Which of the following describes how fuel oil is obtained from crude oil during fractional distillation?

1 boiling followed by evaporation

2 evaporation followed by boiling

3 evaporation followed by condensation

4 condensation followed by evaporation

5C Which of the following is a correct list of gases that might be produced by burning fuel oil?

1 carbon dioxide, water vapour, sulfur dioxide, carbon monoxide

2 hydrogen, carbon dioxide, sulfur dioxide, carbon monoxide

3 sulfur dioxide, carbon dioxide, water vapour, hydrogen

4 carbon, water vapour, sulfur dioxide, carbon monoxide

4.9.3.1 Atmospheric pollutants from fuels

Question 32 · continued

5D Which row in the table correctly describes the type of combustion **and** a substance produced when fuel oil is burned?

	Type of combustion	Substance produced
1	Incomplete	Hydrogen
2	Complete	Carbon particles
3	Incomplete	Carbon particles
4	Complete	Carbon monoxide

Turn over for the next question

4.9.3.1 Atmospheric pollutants from fuels

Question 33

June 2010 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

Petrol is a hydrocarbon fuel that burns in air. Air is mainly nitrogen.

In a car engine:

- not all of the petrol burns completely
- after burning, the products pass into the exhaust pipe.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A nitrogen dioxide

B carbon monoxide

C carbon dioxide

D soot (carbon)

The black solid seen inside the exhaust pipe is . . . **1** . . . .

The gas in the exhaust fumes formed by the complete combustion of petrol is . . . **2** . . . .

The poisonous gas in the exhaust fumes formed by incomplete combustion of petrol is . . . **3** . . . .

The gas in the exhaust fumes formed by combining two gases from the air is . . . **4** . . . .

4.9.3.1 Atmospheric pollutants from fuels

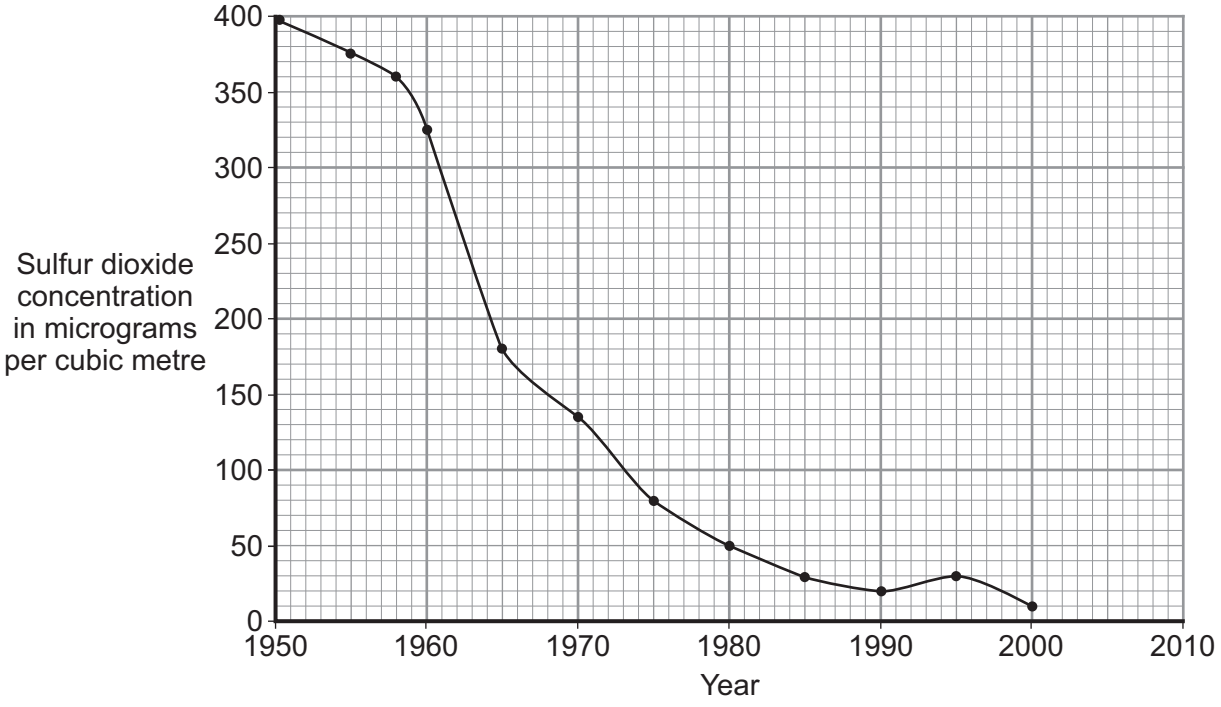
Question 34

June 2010 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

The graph shows how sulfur dioxide concentrations in the atmosphere above London changed between 1950 and 2000.

The table shows the energy used in London in 1950 and in 2000.



Year	Energy used in arbitrary units							
	Petrol	Diesel	Electricity	Oil	House coal	Other solid fuels	Gas	Total
1950	10	5	20	25	100	110	60	330
2000	60	20	130	10	0	10	310	540

7A The information in the graph and table suggests that sulfur dioxide levels have decreased due to . . .

1 an increase in the use of petrol.

2 a decrease in the use of coal and other solid fuels.

3 an increase in the use of electricity that is generated at coal-burning power stations.

4 an increase in the use of diesel.

4.9.3.1 Atmospheric pollutants from fuels

Question 34 · continued June 2010 | CHY1AP | Original Q7 | Legacy

7B Which one of the following is a reason why a prediction for sulfur dioxide concentration in 2010 might be unreliable?

1 Sulfur dioxide has a natural cycle in London of increasing and decreasing.

2 Sulfur dioxide dissolves in water to produce acid rain.

3 The concentration of sulfur dioxide has, in previous years, both increased and decreased.

4 Sulfur dioxide is very difficult to measure in such small concentrations.

7C It was found that the amount of sulfur dioxide from transport increased during years 2000 to 2004, even though many more cars were using low-sulfur fuels.

The reason for this could be . . .

1 a decrease in the use of transport.

2 the introduction of more efficient cars that burn less fuel.

3 an increase in the number of cars used in London.

4 an increase in the price of crude oil.

7D A newspaper published an article about sulfur dioxide concentrations in the atmosphere above London. It stated that in one five-year period, sulfur dioxide levels had fallen by about 44 %.

The five-year period was . . .

1 1960–1965.

2 1965–1970.

3 1985–1990.

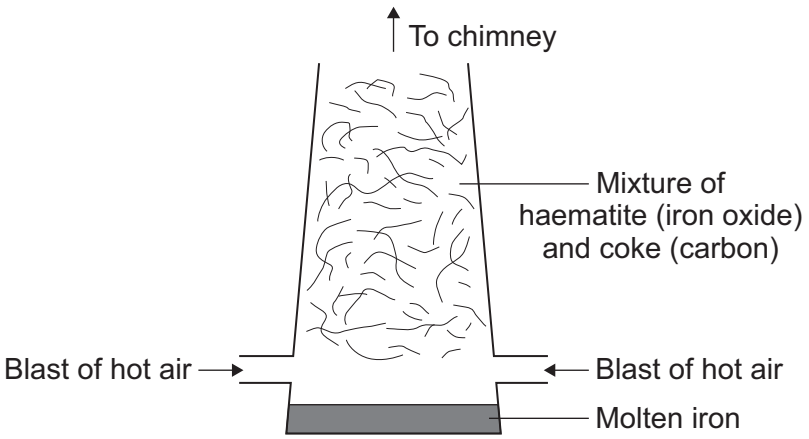
4 1995–2000.

4.9.3.1 Atmospheric pollutants from fuels

Question 35

June 2010 | CHY1H | Original Q3 | Legacy

3 Iron is produced by reacting a mixture of haematite and coke in a blast furnace.
Haematite is an ore of iron containing iron oxide (Fe_2O_3).
Coke is made from coal and is almost pure carbon.



3 (a) (i) The coke burns in air. This reaction heats the furnace to above 1300 °C.

Complete the chemical equation for carbon reacting with oxygen to form carbon dioxide.

..... + O_2 → CO_2

(1 mark)

3 (a) (ii) Carbon monoxide is also formed in the furnace. Carbon monoxide reacts with iron oxide to produce iron and carbon dioxide.

iron oxide + carbon monoxide → iron + carbon dioxide

Complete and balance the chemical equation for the production of iron.

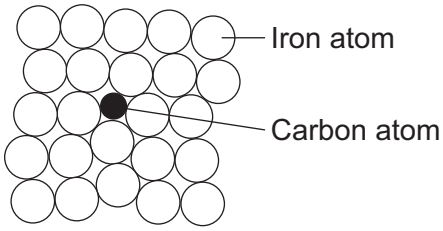
Fe_2O_3 + 3CO → ..... + ...

(2 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 35 · continued June 2010 | CHY1H | Original Q3 | Legacy

3 (a) (iii) Iron from a blast furnace is called cast iron and contains about 4% carbon.



Why is pure iron softer than cast iron?

.....

.....

.....

(1 mark)

3 (b) Steel is made by reducing the percentage of carbon in cast iron and then adding different metals to form the type of steel required.

In the UK we use about 1.8 billion steel cans every year but only 30% of these are recycled. Recycling reduces waste. Producing steel from recycled cans requires only 25% of the energy needed to make steel from iron ore.

Give **three** environmental benefits of recycling a higher percentage of used steel cans.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

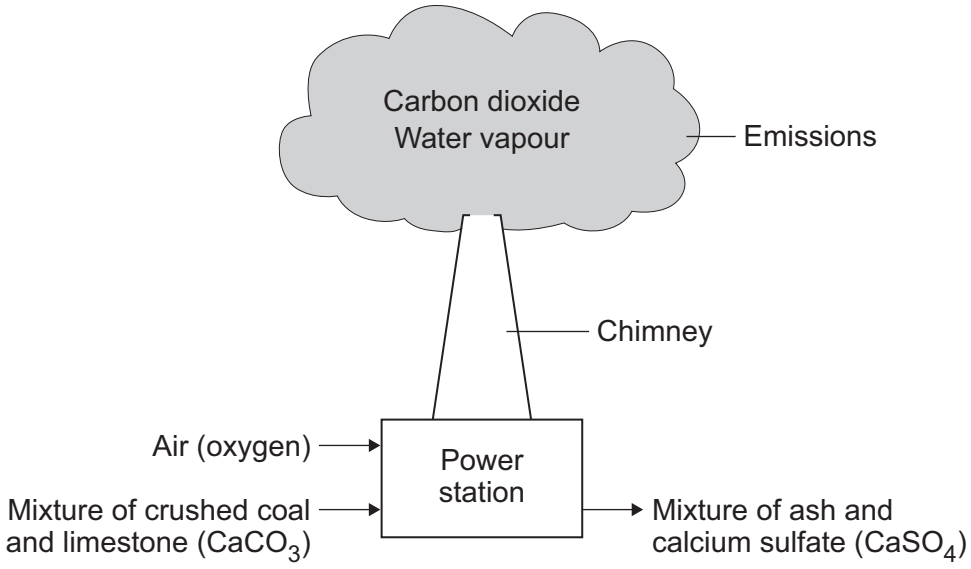
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4.9.3.1 Atmospheric pollutants from fuels

Question 36

June 2010 | CHY1H | Original Q5 | Legacy

5 Most power stations burn coal to generate electricity. Burning coal gives off sulfur dioxide gas which can be removed from the waste gases by using limestone. This prevents sulfur dioxide from entering the atmosphere and causing acid rain. One disadvantage of using limestone in a power station is that it releases 'locked up carbon dioxide' into the atmosphere.



5 (a) How does the limestone used in a power station:

5 (a) (i) release carbon dioxide

.....

.....

(1 mark)

5 (a) (ii) remove sulfur dioxide?

.....

.....

(1 mark)

4.9.3.1 Atmospheric pollutants from fuels

Question 36 · continued

5 (b) The waste gases from the chimney are monitored. One toxic gas that should not be released is carbon monoxide.

Explain how carbon monoxide would be formed.

.....

.....

.....

.....

(2 marks)

5 (c) The use of limestone in a power station releases 'locked up carbon dioxide' into the atmosphere.

5 (c) (i) Explain the meaning of 'locked up carbon dioxide'.

.....

.....

.....

.....

(2 marks)

5 (c) (ii) Why does the release of this carbon dioxide cause an environmental problem?

.....

.....

.....

(1 mark)

7

4.9.3.1 Atmospheric pollutants from fuels

Question 37

November 2010 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

The table shows the quantity of acidic gases produced in Britain, from different sources, between 1990 and 2004.

	Acidic gases produced in millions of tonnes			
Year	**Domestic**	**Transport and communications**	**Other industries**	**Total**
1990	0.75	0.75	5.40	6.90
1992	0.75	0.80	5.00	6.55
1994	0.70	0.80	4.10	5.60
1996	0.60	0.80	3.40	4.80
1998	0.50	0.85	2.90	4.25
2000	0.45	0.70	2.50	3.65
2002	0.40	0.85	2.15	3.40
2004	0.35	0.90	2.05	3.30

6A The decrease in the total amount of acidic gases produced between 1990 and 2004 is about . . .

1 5%.

2 25%.

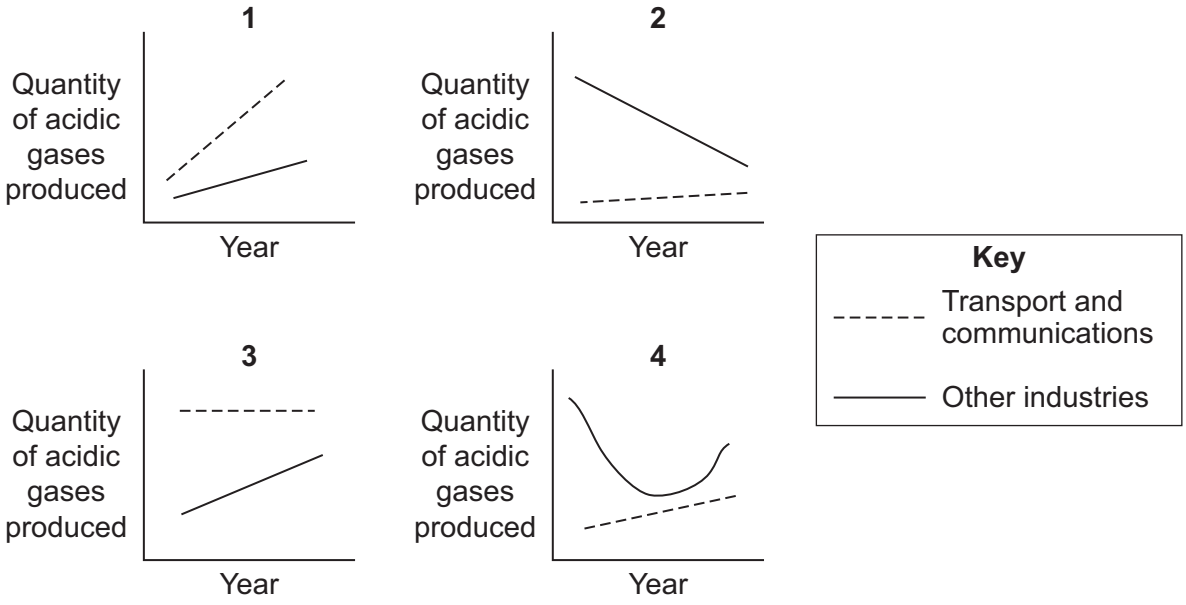
3 50%.

4 75%.

4.9.3.1 Atmospheric pollutants from fuels

Question 37 · continued

6B Which graph correctly shows the data in the table for 'Transport and communications' and for 'Other industries'?



6C In 2000, 'Transport and communications' produced an unexpected amount of acidic gases, when compared to the trend in values.

Which one of the following could help to explain the unexpected amount of acidic gases produced?

1 a decrease in the number of aircraft flights

2 a decrease in the cost of crude oil

3 more traffic on the roads because of an increase in car production

4 more homes being built in the countryside

6D A catalytic converter in the exhaust system of vehicles can remove carbon monoxide and nitrogen dioxide. The two gases, carbon monoxide (CO) and nitrogen dioxide (NO_2), react to produce carbon dioxide (CO_2) and nitrogen (N_2).

The balanced equation that correctly describes this reaction is:

1 $CO + NO_2 \rightarrow CO_2 + N_2$

2 $2CO + NO_2 \rightarrow 2CO_2 + N_2$

3 $3CO + 2NO_2 \rightarrow 3CO_2 + N_2$

4 $4CO + 2NO_2 \rightarrow 4CO_2 + N_2$

4.9.3.1 Atmospheric pollutants from fuels

Question 38

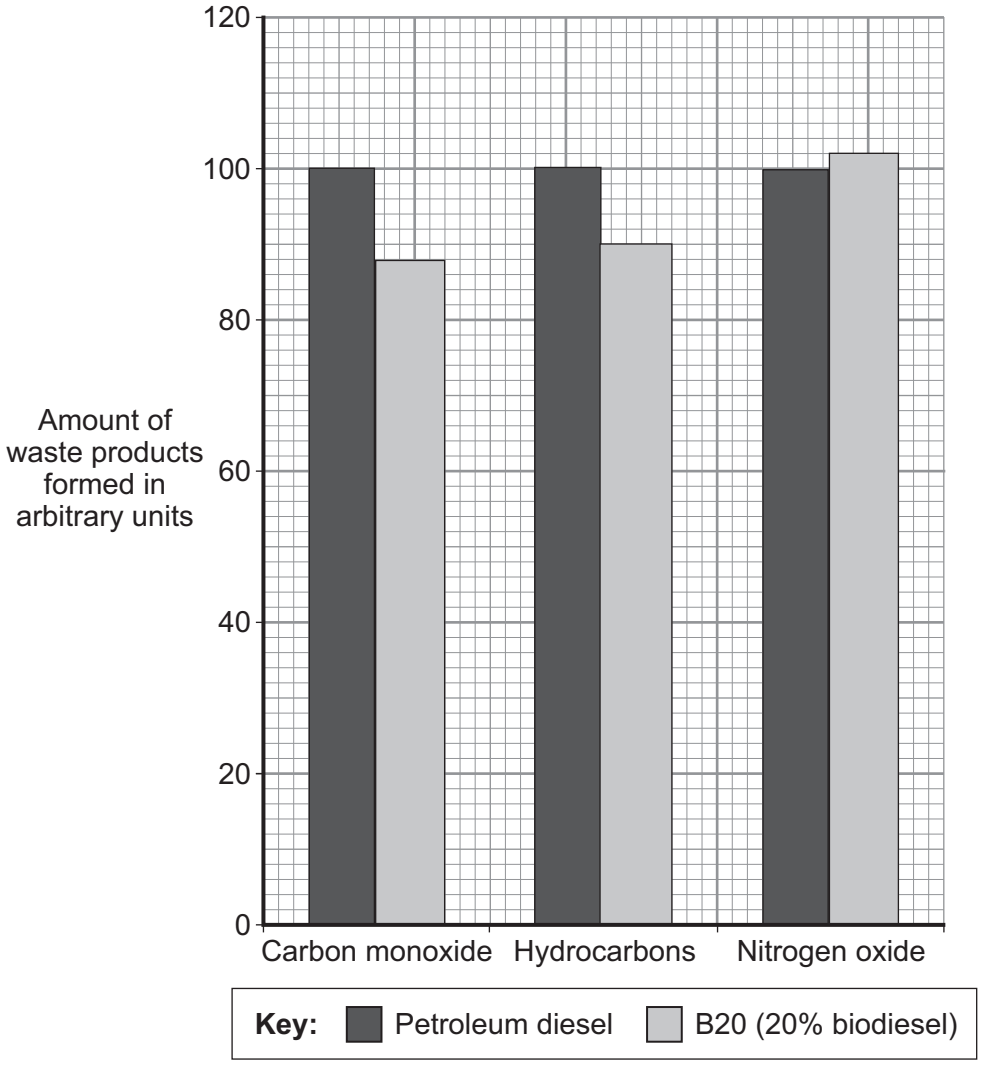
November 2010 | CHY1BP | Original Q6 | Legacy

QUESTION SIX

Petroleum diesel fuel is made from crude oil. Biodiesel fuel is made from vegetable oils.

Some diesel cars can use petroleum diesel mixed with different amounts of biodiesel.
For example, B20 is 20 % biodiesel and 80 % petroleum diesel.

The bar chart shows the waste products from burning petroleum diesel and B20. The amounts of the three waste products are shown for each fuel.



6A Which of the following is a correct statement about these waste products?

1 They are all oxides.

2 They all contain carbon.

3 They are all elements.

4 They are all compounds.

4.9.3.1 Atmospheric pollutants from fuels

Question 38 · continued

6B When B20 burns in a diesel engine, the other waste products are likely to be . . .

1 carbon dioxide, oxygen and water vapour.

2 nitrogen, water vapour and sulfur dioxide.

3 carbon dioxide, water vapour and sulfur dioxide.

4 oxygen, water vapour and sulfur dioxide.

6C Which row in the table shows a correct advantage and a correct disadvantage of using B20 instead of petroleum diesel?

	Advantage of using B20	Disadvantage of using B20
1	It is partly renewable.	It produces a greater amount of all harmful waste products.
2	It is unsaturated.	It is non-biodegradable.
3	It is partly renewable.	It produces an increased amount of nitrogen oxide.
4	It is hydrogenated.	It produces more carbon monoxide.

6D B100 is 100 % biodiesel. Net carbon dioxide emissions are lower for B100 than for petroleum diesel.

This is because . . .

1 the carbon dioxide is used by plants for photosynthesis.

2 vegetable oils produce very little carbon dioxide when they burn.

3 biodiesel does not contain any hydrocarbons.

4 carbon dioxide dissolves in the oceans.

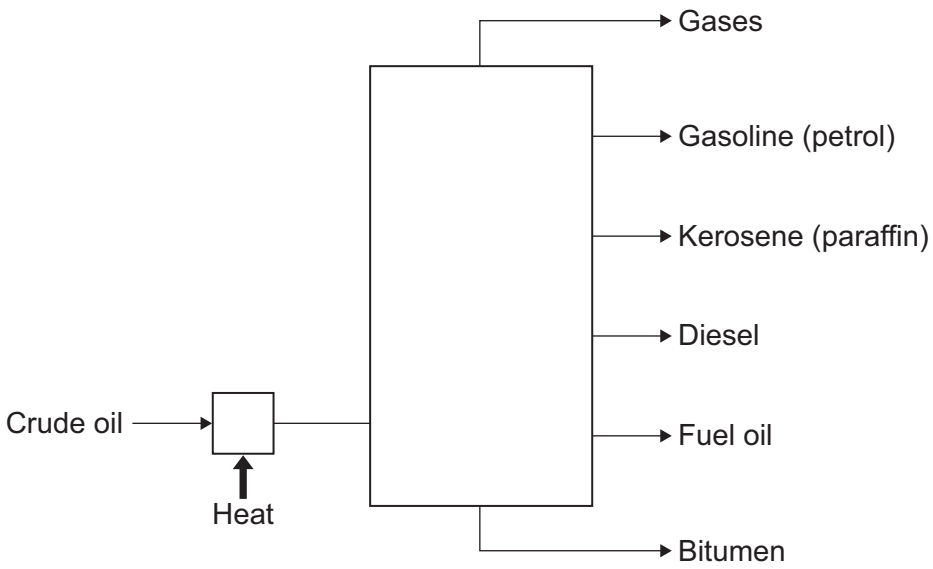
4.9.3.1 Atmospheric pollutants from fuels

Question 39

January 2011 | CHY1H | Original Q2 | Legacy

2 Crude oil is used to produce many useful materials.

2 (a) The diagram shows some of the fractions produced from crude oil by fractional distillation.



Use the diagram to help you to explain how crude oil is separated into fractions.

You should use the words evaporated and condensed in your answer.

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(3 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 39 · continued

2 (b) The table shows some information about four of the fractions from crude oil that are used as fuels.

Fraction	Boiling point in °C	Number of carbon atoms found in the molecules
Gasoline (petrol)	20 – 200	5 – 10
Kerosene (paraffin)	180 – 260	10 – 16
Diesel	260 – 340	14 – 20
Fuel oil	370 – 600	20 – 70

Use the information in the table to help you to answer these questions.

2 (b) (i) How can you tell that each of the fractions is a mixture?

.....

.....

(1 mark)

2 (b) (ii) How does the number of carbon atoms in a molecule affect its boiling point?

.....

.....

(1 mark)

2 (c) Fuels are substances that release energy.

2 (c) (i) Name the reaction that releases energy from a fuel such as gasoline (petrol).

.....

(1 mark)

2 (c) (ii) Describe how fuel oil is broken down into smaller, more useful molecules such as gasoline (petrol).

.....

.....

.....

.....

(2 marks)

8

4.9.3.1 Atmospheric pollutants from fuels

Question 40

January 2011 | CHY1H | Original Q6 | Legacy

6 This information about diesel was printed in a magazine.

Almost all of the crops that we eat can be converted into fuel for cars.
Vegetable oils can be used as biodiesel. Diesel from crude oil is called fossil diesel.
When either biodiesel or fossil diesel burn they both produce similar amounts of carbon dioxide.
Both types of diesel produce carbon monoxide. However, biodiesel produces fewer carbon particles and less sulfur dioxide.

6 (a) Carbon monoxide can be produced when diesel burns in a car engine. Explain how.

.....

.....

.....

.....

(2 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 40 · continued

6 (b) Use the information at the start of this question and your knowledge and understanding to evaluate the use of biodiesel compared with fossil diesel as a fuel for cars.

Remember to give a conclusion to your evaluation.

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(5 marks)

7

4.9.3.1 Atmospheric pollutants from fuels

Question 41

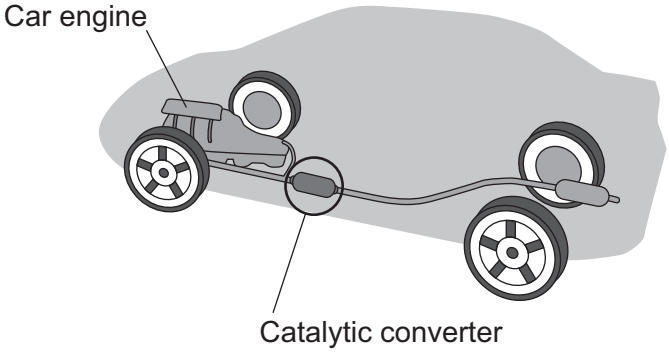
January 2011 | CHY2H | Original Q4 | Legacy

4 Read the information about car engines.

Burning petrol in air is an *exothermic* reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

A catalytic converter stops these harmful substances being released into the air.



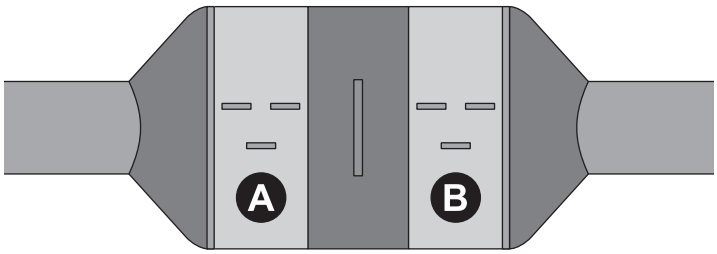
4 (a) The reaction is *exothermic*. What is the meaning of *exothermic*?

.....

.....

(1 mark)

4 (b) The catalytic converter has two parts shown as **A** and **B** in the diagram.



Part **A** contains a catalyst made from platinum and rhodium.

Part **B** contains a catalyst made from platinum and palladium.

4.9.3.1 Atmospheric pollutants from fuels

Question 41 · continued

4 (b) (i) Why are catalysts used in chemical reactions?

.....

.....

(1 mark)

4 (b) (ii) One reaction in part **A** is shown by this equation.

$$2NO \rightarrow N_2 + O_2$$

Suggest why this reaction helps the environment.

.....

.....

(1 mark)

4 (b) (iii) The equation for one of the reactions in part **B** is shown below.

Balance this equation.

..... CO + O_2 → ..... CO_2

(1 mark)

4 (b) (iv) The catalytic converter works for many years without replacing the catalyst.

Explain why the catalyst does not need to be replaced.

.....

.....

(1 mark)

4 (b) (v) Suggest why different catalysts are used in parts **A** and **B**.

.....

.....

(1 mark)

Question 4 continues on the next page

4.9.3.1 Atmospheric pollutants from fuels

Question 41 · continued

4 (c) Modern catalytic converters contain nanosized particles of catalyst. Using nanosized particles reduces the cost of the catalytic converter.

Suggest and explain why the use of nanosized catalyst particles reduces the cost of the catalytic converter.

Your answer should include information about the size and surface area of the particles.

.....

.....

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.....

.....

.....

(3 marks)

9

4.9.3.1 Atmospheric pollutants from fuels

Question 42

January 2011 | CHY2H | Original Q6 | Legacy

6 The picture shows a wooden bowl.
The pieces of wood used for this bowl were dyed different colours.



The artist who made the bowl explained why he dissolved the coloured dyes in methanol.

> I use different coloured dyes dissolved in methanol.
> I use methanol because with dyes dissolved in water the wood needs to be soaked for a longer time.
> The bowl dries more quickly if I use methanol instead of water.

6 (a) (i) Why is using methanol an advantage to the artist?

.....

.....

(1 mark)

6 (a) (ii) The bonds within a methanol molecule are strong, covalent bonds.

Explain why methanol has a low boiling point.

.....

.....

.....

.....

.....

(2 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 42 · continued

6 (b) Methanol is made by reacting carbon monoxide with hydrogen.

The equation for this reaction is:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

The best equilibrium yield of methanol is obtained when the temperature is low and when the pressure is high.

Explain why the best equilibrium yield is obtained:

6 (b) (i) when the temperature is low

.....

.....

(1 mark)

6 (b) (ii) when the pressure is high.

.....

.....

(1 mark)

6 (b) (iii) In industry a high temperature is used for this reaction. This gives a fast rate of reaction. The increase in temperature gives the particles more energy.

Explain, in terms of particles, why this makes the reaction go faster.

.....

.....

.....

.....

.....

.....

(2 marks)

Question 6 continues on the next page

4.9.3.1 Atmospheric pollutants from fuels

Question 42 · continued January 2011 | CHY2H | Original Q6 | Legacy

6 (c) (i) Calculate the maximum mass of methanol that could be made from 14 g of carbon monoxide.

$$CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$$

Relative formula masses (M_r): CO = 28; CH_3OH = 32.

.....

.....

.....

.....

.....

Maximum mass of methanol = ... g
(2 marks)

6 (c) (ii) In an experiment the actual mass of methanol made from 14 g of carbon monoxide was 12 g. Use this information and your answer from part (c)(i) to calculate the percentage yield of methanol in this experiment.

(If you did not get an answer to part (c)(i) then assume that the maximum yield is 18 g. This is **not** the correct answer to part (c)(i).)

.....

.....

Percentage yield of methanol = ...%
(2 marks)

6 (c) (iii) Suggest **one** reason why the yield obtained is less than the maximum yield.

.....

.....
(1 mark)

12

4.9.3.1 Atmospheric pollutants from fuels

Question 43

March 2011 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

This question is about substances that burn in air and the gases they produce.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A Carbon monoxide (CO)

B Hydrogen (H_2)

C Methane (CH_4)

D Hydrogen sulfide (H_2S)

	Gases produced when the substance burns in air
1	carbon dioxide (CO_2) and water vapour (H_2O)
2	water vapour (H_2O) only
3	water vapour (H_2O) and sulfur dioxide (SO_2)
4	carbon dioxide (CO_2) only

4.9.3.1 Atmospheric pollutants from fuels

Question 44

March 2011 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Alcohols have the general formula $C_nH_{2n+1}OH$
The OH group is known as the functional group for alcohols.
Alcohols with a value of 'n' less than 4 burn completely in air without producing any carbon particles.
Alcohols with a value of 'n' greater than 4 do not burn completely in air and produce carbon particles.

Some properties of alcohols are listed in the table.

'n' value of the alcohol	Melting point in ºC	Boiling point in ºC	Solubility in water
2	−117	79	Very soluble
4	−89	117	Soluble
6	−47	158	Slightly soluble
8	−17	195	Insoluble

6A Which of the following formulae represents the alcohol with a value of n = 4?

1 C_4H_5OH

2 C_4H_8OH

3 C_4H_9OH

4 $C_4H_{10}OH$

6B An alcohol has a value of n = 10.

Which row in the table shows the likely properties of this alcohol?

	Melting point in ºC	Boiling point in ºC	Solubility in water
1	10	230	Insoluble
2	−4	235	Slightly soluble
3	0	200	Insoluble
4	5	200	Slightly soluble

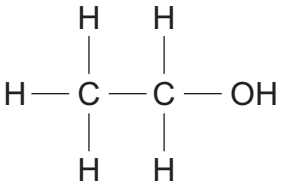
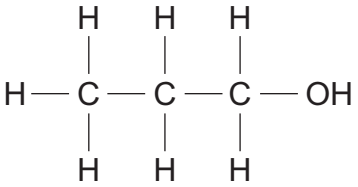
4.9.3.1 Atmospheric pollutants from fuels

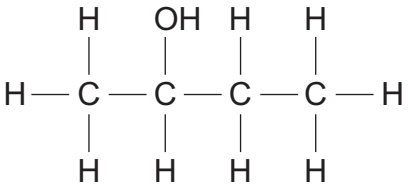
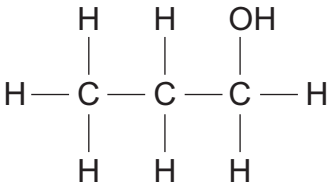
Question 44 · continued

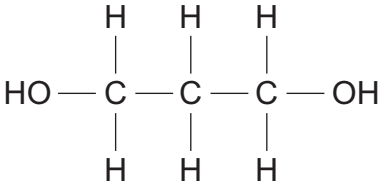
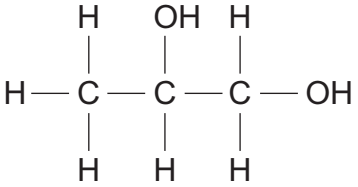
March 2011 | CHY1AP | Original Q6 | Legacy

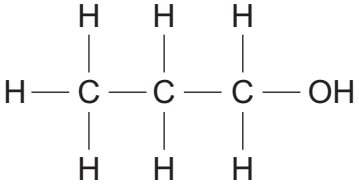
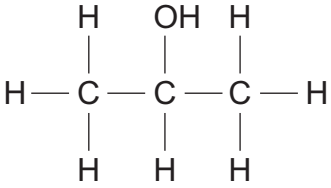
6C There are two possible structures for an alcohol with a value of n = 3.

Which are the two correct structures?

1  and 

2  and 

3  and 

4  and 

6D What are the likely products from burning in air an alcohol with a value of n = 8?

1 carbon dioxide and water only

2 carbon dioxide, carbon particles and water

3 carbon dioxide and carbon particles

4 carbon dioxide, sulfur dioxide and water

4.9.3.1 Atmospheric pollutants from fuels

Question 45

March 2011 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

Zinc is a reactive metal that will react with oxygen at high temperatures. Its two main ores are zinc sulfide (ZnS) and zinc carbonate ($ZnCO_3$). The relative abundance of each ore is about the same throughout the world.

To extract zinc, the ores are first heated to produce zinc oxide:

$$2ZnS + 3O_2 \xrightarrow{\text{heat}} 2ZnO + 2SO_2$$

$$ZnCO_3 \xrightarrow{\text{heat}} ZnO + CO_2$$

The zinc oxide is mixed with carbon (C) and heated in a furnace.

In the furnace, these reactions occur:

$$C + O_2(air) \xrightarrow{\text{heat}} CO_2$$

$$CO_2 + C \longrightarrow 2CO$$

Zinc is extracted by the following reaction:

$$ZnO + CO \longrightarrow Zn + CO_2$$

8A An advantage of using zinc carbonate instead of zinc sulfide is that. . .

1 zinc carbonate is more common and therefore cheaper.

2 only one waste product is formed.

3 less zinc is lost during the reaction.

4 zinc is formed directly without another chemical being used.

8B The atmosphere inside the furnace is kept rich in carbon monoxide (CO).

This is to . . .

1 prevent zinc oxide from reacting with carbon (C).

2 stop the zinc from re-forming zinc oxide.

3 remove carbon (C) from the furnace.

4 make carbon dioxide (CO_2).

4.9.3.1 Atmospheric pollutants from fuels

Question 45 · continued

March 2011 | CHY1AP | Original Q8 | Legacy

8C Zinc ores also contain lead compounds. Lead is produced with the zinc in the furnace. The temperature inside the furnace is about 1500 °C.

	Boiling point in °C	Density in g per cm^3	Reactivity
Lead	1749	11.3	Low
Zinc	907	7.1	High

Pure zinc is obtained from the furnace because . . .

1 zinc leaves the furnace as vapour, and liquid lead remains in the furnace.

2 liquid zinc floats on liquid lead in the furnace.

3 lead leaves the furnace as vapour, and liquid zinc remains in the furnace.

4 lead is more reactive than zinc and reacts with oxygen to form lead oxide.

8D Limestone is added to the furnace because . . .

1 it provides energy for the reaction.

2 it removes any acidic impurities.

3 it is the only source of the carbon dioxide in the furnace.

4 it is thermally stable.

4.9.3.1 Atmospheric pollutants from fuels

Question 46

March 2011 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

The table gives information about some of the gases in air.

Name	Formula	Melting point in °C	Boiling point in °C
Helium	He	–272.2	–269.0
Oxygen	O_2	–219.0	–183.0
Nitrogen	N_2	–210.0	–195.9
Argon	Ar	–189.0	–185.9
Carbon dioxide	CO_2	–78.5	–78.5
Water vapour	H_2O	0.0	100.0

To separate these gases, they are compressed and cooled.

- Water is first removed.
- Carbon dioxide is then removed by absorption.
- The gases remaining are cooled to –200 °C.

5A Why are water vapour and carbon dioxide first removed?

1 They are both compounds and the rest are elements.

2 They both contribute to global warming.

3 They would both solidify and block the pipes.

4 The carbon dioxide would dissolve in the water.

5B After the removal of water and carbon dioxide, which row in the table below shows the physical states of the remaining elements at –200 °C?

	Helium	Oxygen	Nitrogen	Argon
1	gas	liquid	liquid	solid
2	liquid	gas	solid	liquid
3	gas	liquid	solid	solid
4	solid	gas	liquid	gas

4.9.3.1 Atmospheric pollutants from fuels

Question 46 · continued

March 2011 | CHY1BP | Original Q5 | Legacy

5C After the removal of water and carbon dioxide, which of the gases remaining would stay liquid over the greatest temperature range?

1 helium

2 oxygen

3 nitrogen

4 argon

5D After the gases are cooled to −200 °C and then allowed to warm up, which of the following gives the order in which they would vaporise?

1 oxygen, nitrogen, argon

2 nitrogen, argon, oxygen

3 argon, nitrogen, oxygen

4 oxygen, argon, nitrogen

Turn over for the next question

4.9.3.1 Atmospheric pollutants from fuels

Question 47

June 2011 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about four carbon compounds that burn in air.

Match compounds, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A CO

B CS_2

C C_2H_4

D C_3H_8

1	It burns to form carbon dioxide only.
2	It is a hydrocarbon but it is not an alkane.
3	It is in the series with the general formula C_nH_{2n+2}
4	It burns to form carbon dioxide and sulfur dioxide.

4.9.3.1 Atmospheric pollutants from fuels

Question 48

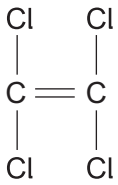
June 2011 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

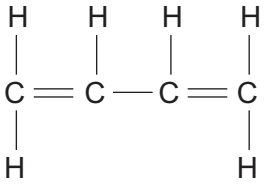
This question is about four carbon compounds.

Match compounds, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

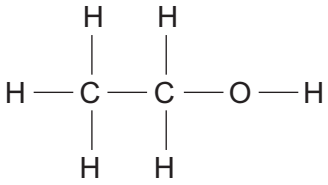
A



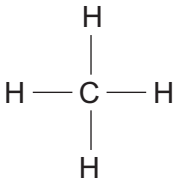
B



C



D



	Description
1	It is not a hydrocarbon but burns to give carbon dioxide and water.
2	It is a saturated hydrocarbon used as a fuel.
3	It will not produce water vapour if it burns.
4	It belongs to a group of compounds with the general formula C_nH_{2n-2}

4.9.3.1 Atmospheric pollutants from fuels

Question 49

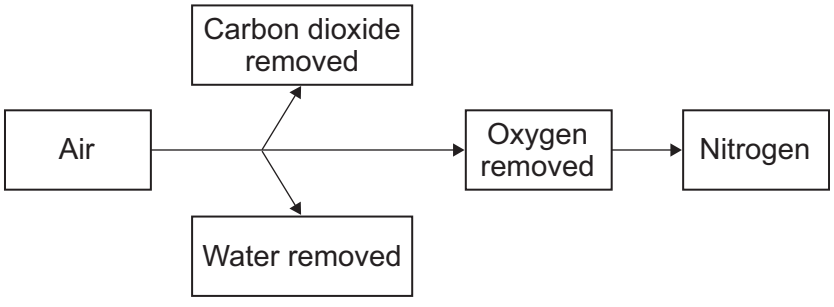
QUESTION NINE

The table below gives information about the gases in the air after removal of any water vapour.

Gas	Melting point in °C	Boiling point in °C	Abundance in %
Nitrogen	−209	−196	78
Oxygen	−223	−183	21
Carbon dioxide	−57	−57	0.03
Helium	−272	−269	Less than 0.1
Neon	−248	−246	Less than 0.1
Argon	−189	−186	0.9
Krypton	−157	−153	Less than 0.1
Xenon	−112	−108	Less than 0.1

In 1892, scientists believed that the air consisted of three gases, nitrogen, oxygen and carbon dioxide.

Lord Rayleigh extracted nitrogen from the air.



He also collected very pure nitrogen by heating ammonium nitrate.

He found that there was a slight difference in the densities of the nitrogen samples from the two different sources.

- Density of nitrogen from the air = 1.2572 g per litre
- Density of nitrogen from ammonium nitrate (NH_4NO_3) = 1.2511 g per litre

4.9.3.1 Atmospheric pollutants from fuels

Question 49 · continued

9A A correct conclusion from this information is that . . .

1 hydrogen, a gas with a very low density, is present in the nitrogen from ammonium nitrate.

2 the nitrogen from the air contains a small amount of hydrogen.

3 a gas that is heavier than nitrogen is mixed with the nitrogen from the air.

4 some carbon dioxide was given off when the ammonium nitrate was heated.

9B It was several years after 1892 when the other gases in the table were identified.

This was because these other gases . . .

1 are colourless.

2 have a very low density.

3 are unreactive.

4 have very low boiling points.

The separation of gases in the air is done in several stages:

- carbon dioxide is first removed
- the air is then cooled to –200 °C so that it liquefies
- the liquefied air is allowed to warm up
- two main fractions, oxygen and nitrogen, are collected
- a third fraction that is mainly argon is also collected.

9C Why is the carbon dioxide removed before the air is liquefied?

1 It is present only in very small quantities.

2 It is a compound and the other gases are elements.

3 It would solidify during cooling and cause blockages in the pipes.

4 Its density is very similar to the density of argon.

9D What is the order in which these fractions boil off from the liquefied air?

1 argon, nitrogen, oxygen

2 oxygen, nitrogen, argon

3 nitrogen, argon, oxygen

4 argon, oxygen, nitrogen

END OF TEST

4.9.3.1 Atmospheric pollutants from fuels

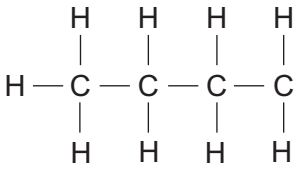
Question 50

June 2011 | CHY1H | Original Q5 | Legacy

5 Crude oil is a mixture of hydrocarbons. Most of these hydrocarbons are alkanes.

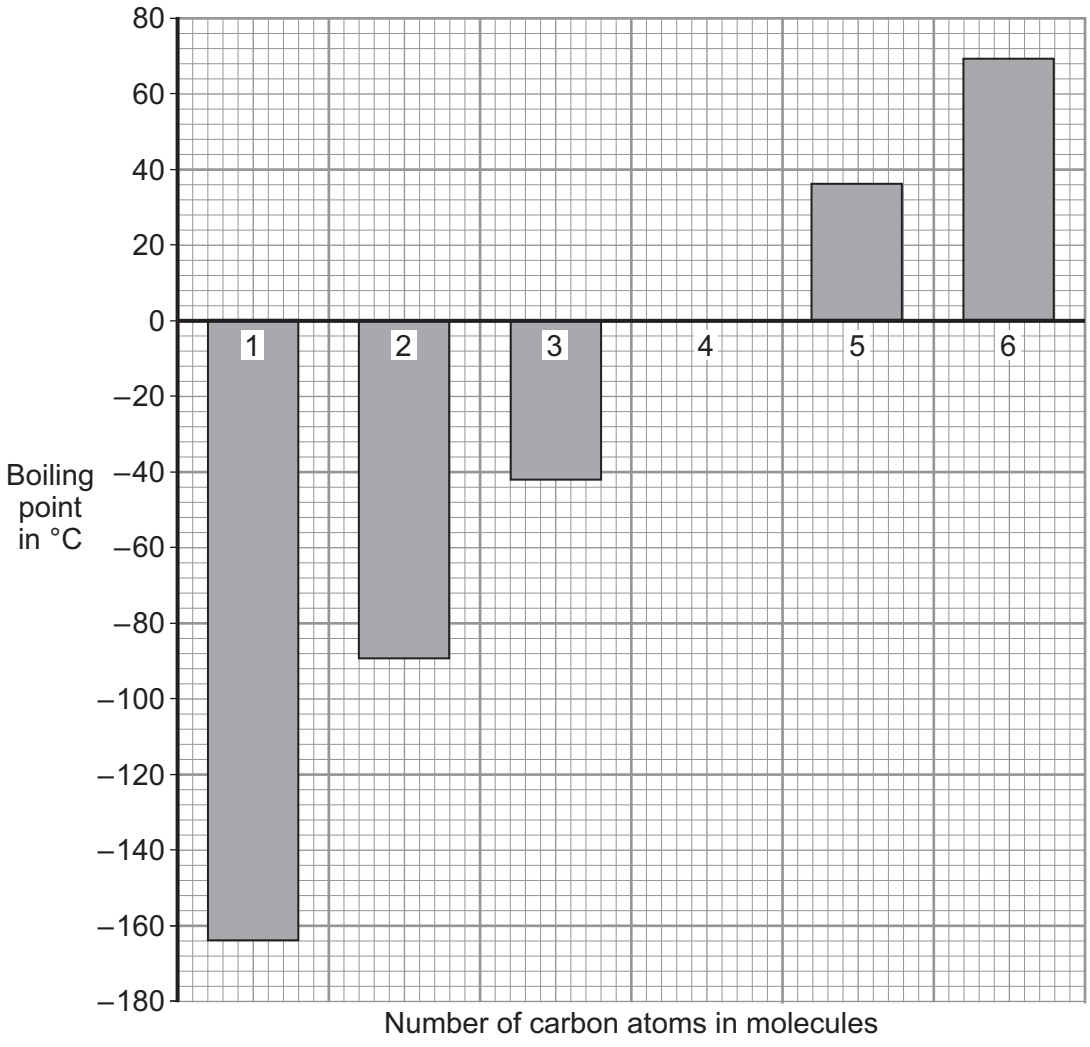
5 (a) The general formula of an alkane is C_nH_{2n+2}

Complete the structural formula for the alkane that has **six** carbon atoms in its molecules.



(1 mark)

5 (b) The boiling points of alkanes are linked to the number of carbon atoms in their molecules.



5 (b) (i) Describe the link between the number of carbon atoms in an alkane molecule and its boiling point.

.....

.....

(1 mark)

4.9.3.1 Atmospheric pollutants from fuels

Question 50 · continued

5 (b) (ii) Suggest **two** reasons why all of the alkanes in the bar chart are better fuels than the alkane with the formula $C_{30}H_{62}$

1 .....

.....

2 .....

.....

(2 marks)

5 (c) During the last 200 million years the carbon cycle has maintained the percentage of carbon dioxide in the atmosphere at about 0.03 %.
Over the last 100 years the percentage of carbon dioxide in the atmosphere has increased to about 0.04 %.
Most of this increase is caused by burning fossil fuels to heat buildings, to generate electricity and to power our transport.
Fossil fuels contain carbon that has been locked up for millions of years.

5 (c) (i) Burning fossil fuels, such as petrol, releases this locked up carbon. Balance the chemical equation for the combustion of one of the alkanes in petrol.

$$2\,C_8H_{18} + 25\,O_2 \longrightarrow \text{.....}\ CO_2 + \text{.....}\ H_2O$$

(1 mark)

5 (c) (ii) Where did the carbon that is locked up in fossil fuels come from?

.....

.....

(1 mark)

5 (c) (iii) The burning of fossil fuels has caused the percentage of carbon dioxide in the atmosphere to increase to above 0.03 %.
Explain why.

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(2 marks)

8

4.9.3.1 Atmospheric pollutants from fuels

Question 51

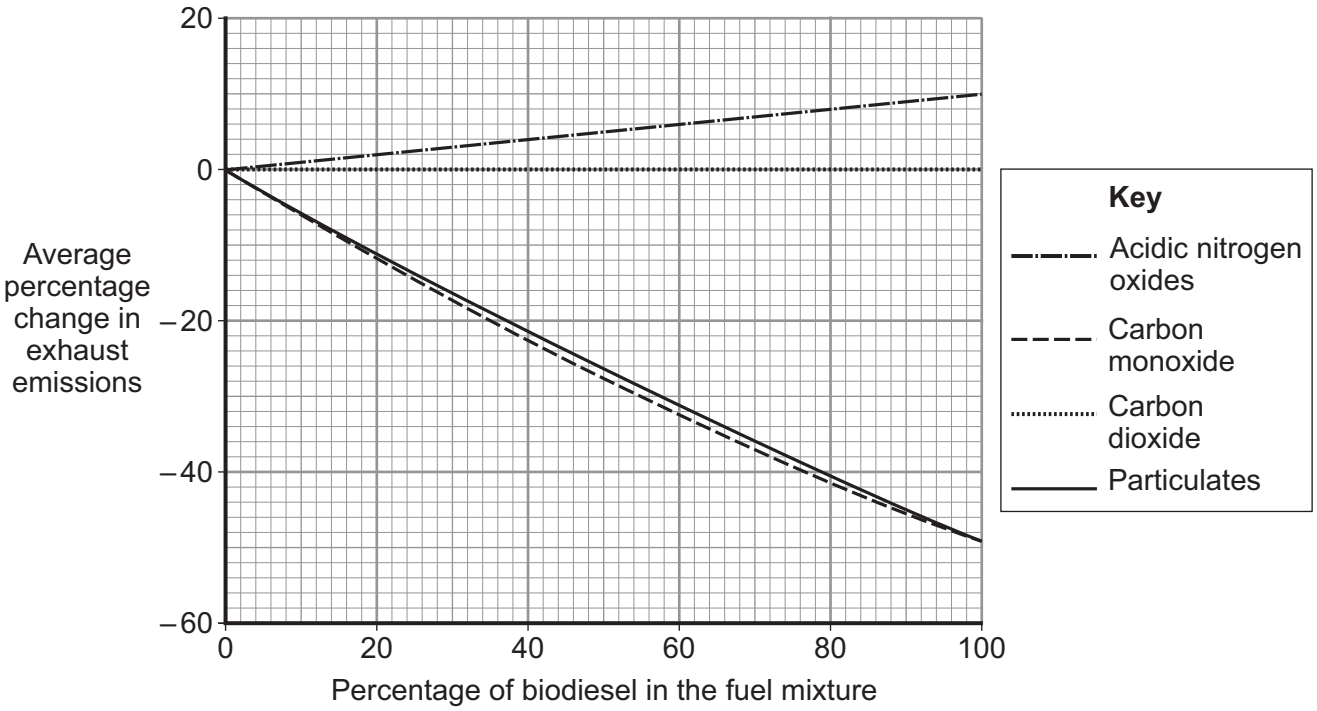
June 2011 | CHY1H | Original Q6 | Legacy

6 Petroleum diesel is produced from crude oil.

Most vehicles that use petroleum diesel as fuel can also use biodiesel or a mixture of these two fuels. In the UK (in 2010) there must be 5% biodiesel in all petroleum diesel fuel.

Biodiesel is produced from plant oils such as soya. The crops used to produce biodiesel can also be used to feed humans. The benefit that biodiesel is 'carbon neutral' is outweighed by the increasing demand for crops. This increasing demand is causing forests to be burnt to provide land for crops to produce biodiesel. Only a huge fall in the price of petroleum diesel would halt the increasing use of biodiesel.

The graph shows the average percentage change in exhaust emissions from vehicles using different mixtures of petroleum diesel and biodiesel.



4.9.3.1 Atmospheric pollutants from fuels

Question 51 · continued

There is no difference in carbon dioxide emissions for all mixtures of petroleum diesel and biodiesel.

Use the information and your knowledge and understanding to evaluate the use of plant oils to produce biodiesel.

Remember to give a conclusion to your evaluation.

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(5 marks)

5

4.9.3.1 Atmospheric pollutants from fuels

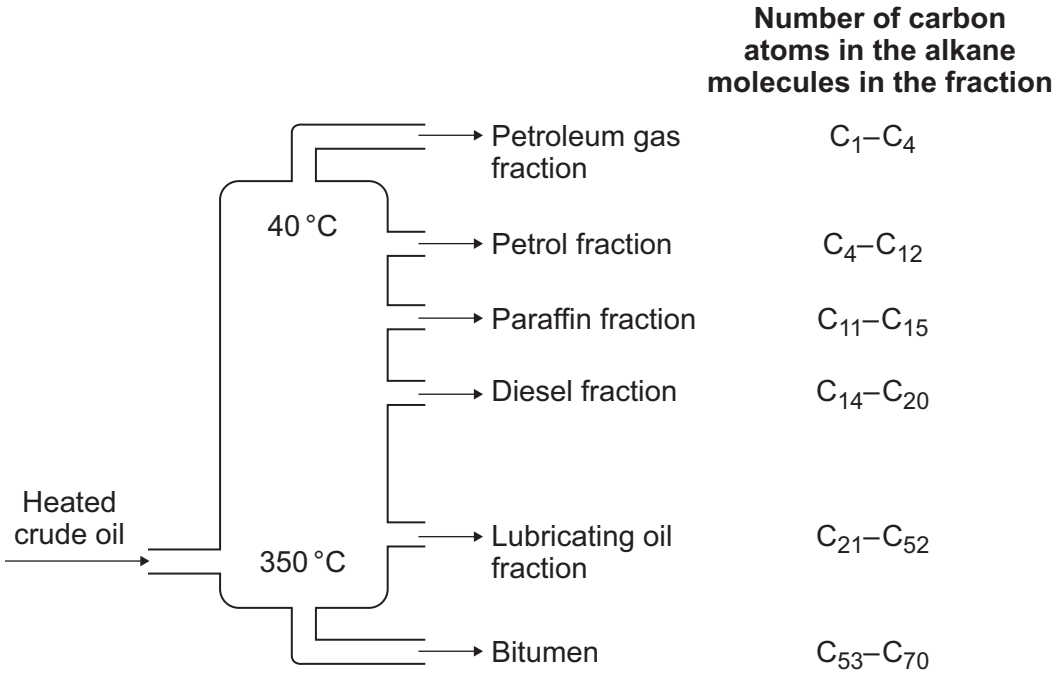
Question 52

November 2011 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

Crude oil can be separated into fractions.

Each fraction contains several alkanes.

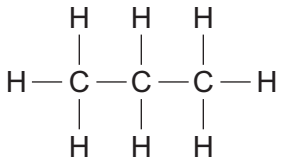


4.9.3.1 Atmospheric pollutants from fuels

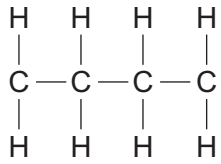
Question 52 · continued

3A One of the alkanes in the petrol fraction can be represented by . . .

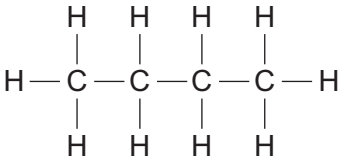
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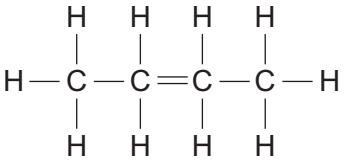
2



3



4



3B When compared with the alkanes in the petrol fraction, the alkanes in the lubricating oil fraction . . .

1 will be more difficult to ignite.

2 will burn with a cleaner flame.

3 will have lower boiling points.

4 will have smaller molecules.

3C The alkane called nonane has 20 hydrogen atoms in each molecule.

In which fraction will it be mainly collected?

1 Petroleum gas fraction

2 Petrol fraction

3 Diesel fraction

4 Lubricating oil fraction

3D Which of these gases **cannot** be produced when a pure alkane burns?

1 carbon monoxide

2 carbon dioxide

3 sulfur dioxide

4 water vapour

4.9.3.1 Atmospheric pollutants from fuels

Question 53

November 2011 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

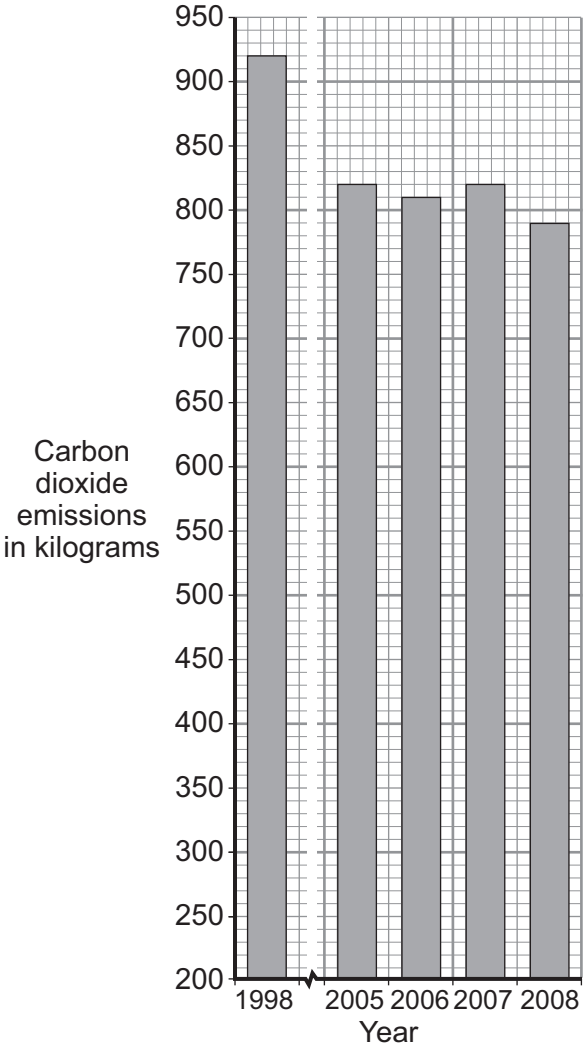
Cement is made in a rotary kiln, from a mixture of limestone and clay. The kiln is heated by burning a hydrocarbon fuel in air.

The cement industry needs to reduce carbon dioxide emissions.

Graphs 1 and **2** show carbon dioxide emissions from cement manufacture in Britain, between 1998 and 2008.

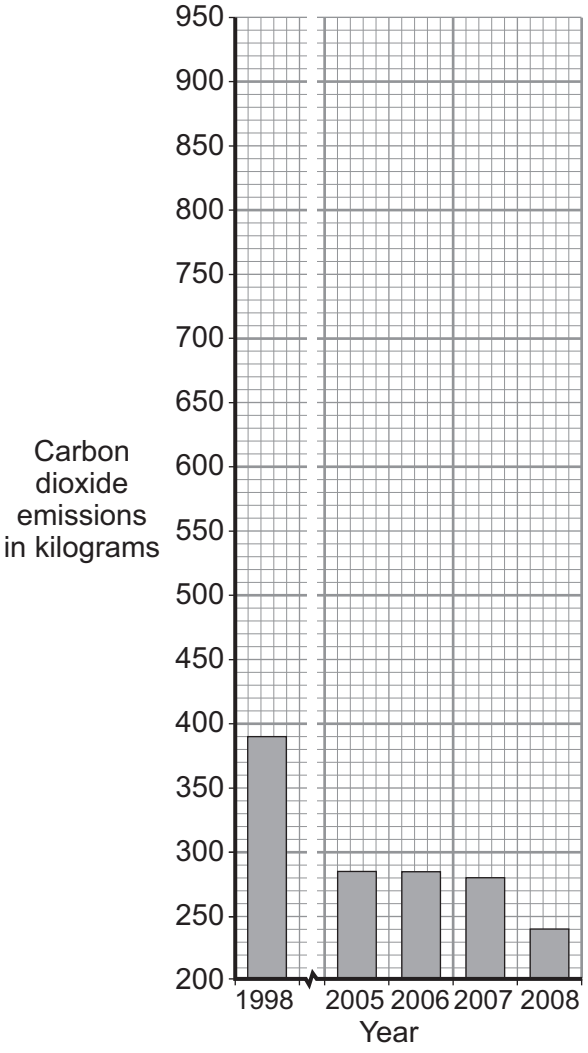
Graph 1

Total carbon dioxide emissions from factories per tonne of cement manufactured



Graph 2

Carbon dioxide emissions from combustion of hydrocarbon fuels per tonne of cement manufactured



4.9.3.1 Atmospheric pollutants from fuels

Question 53 · continued

5A A correct conclusion from the information in the graphs is that . . .

1 the largest reduction in total emissions of carbon dioxide was from 1998 to 1999.

2 the largest reduction in emissions of carbon dioxide from combustion of hydrocarbon fuels was from 2007 to 2008.

3 from 2007 to 2008, total emissions of carbon dioxide, per tonne of cement manufactured, reduced by 40 kilograms.

4 from 2007 to 2008, emissions of carbon dioxide from combustion of hydrocarbon fuels, per tonne of cement manufactured, reduced by 40 kilograms.

5B What was the percentage reduction in emissions of carbon dioxide from combustion of hydrocarbon fuels at cement factories between 1998 and 2008?

1 16.2 %

2 38.5 %

3 61.5 %

4 84.4 %

5C What proportion of the carbon dioxide released during cement manufacture in 2006 came from combustion of hydrocarbon fuels?

1 0.23

2 0.35

3 0.61

4 0.85

5D Most of the carbon dioxide released during cement manufacture comes from . . .

1 hydrocarbons.

2 limestone.

3 quicklime.

4 slaked lime.

4.9.3.1 Atmospheric pollutants from fuels

Question 54

January 2012 | CH1HP | Original Q2 | Legacy

2 A mixture of petrol and air is burned in a car engine.
Petrol is a mixture of alkanes. Air is a mixture of gases.

The tables give information about the composition of petrol and the composition of air.

Petrol	
Alkane	**Formula**
hexane	C_6H_{14}
heptane	
octane	C_8H_{18}
nonane	C_9H_{20}
decane	$C_{10}H_{22}$

Air	
Gas	**Percentage (%)**
nitrogen	78
oxygen	21
carbon dioxide	0.035
Small amounts of other gases and water vapour	

2 (a) Use the information above to answer these questions.

2 (a) (i) Give the formula for heptane.

.....

(1 mark)

2 (a) (ii) Complete the general formula of alkanes.
n = number of carbon atoms

$$C_nH$$

(1 mark)

2 (b) Alkanes in petrol burn in air.
The equations represent two reactions of hexane burning in air.

Reaction 1 $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$

Reaction 2 $2C_6H_{14} + 13O_2 \rightarrow 12CO + 14H_2O$

Reaction 2 produces a different carbon compound to **Reaction 1**.

2 (b) (i) Name the carbon compound produced in **Reaction 2**.

.....

(1 mark)

2 (b) (ii) Give a reason why the carbon compounds produced are different.

.....

.....

(1 mark)

Question 2 continues on the next page

4.9.3.1 Atmospheric pollutants from fuels

Question 54 · continued

2 (c) The table shows the percentages of some gases in the exhaust from a petrol engine.

Name of gas	Percentage (%)
nitrogen	68
carbon dioxide	15
carbon monoxide	1.0
oxygen	0.75
nitrogen oxides	0.24
hydrocarbons	0.005
sulfur dioxide	0.005
other gases	

2 (c) (i) What is the percentage of the other gases in the table?

.....

(1 mark)

2 (c) (ii) What is the name of the compound that makes up most of the other gases?

.....

(1 mark)

2 (c) (iii) Give a reason why sulfur dioxide is produced in a petrol engine.

.....

.....

(1 mark)

2 (c) (iv) State how nitrogen oxides are produced in a petrol engine.

.....

.....

.....

.....

(2 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 54 · continued

2 (d) Many scientists are concerned about the carbon dioxide released from burning fossil fuels such as petrol.

Explain why.

.....

.....

.....

.....

(2 marks)

11

Turn over for the next question

4.9.3.1 Atmospheric pollutants from fuels

Question 55

January 2012 | CH1HP | Original Q6 | Legacy

6 Limestone is used as a building material. Acid rain erodes limestone.

6 (a) Limestone contains calcium carbonate.
The symbol equation for the reaction of calcium carbonate with hydrochloric acid is shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Describe a test to show that carbon dioxide is produced in this reaction.

Give the result of the test.

.....

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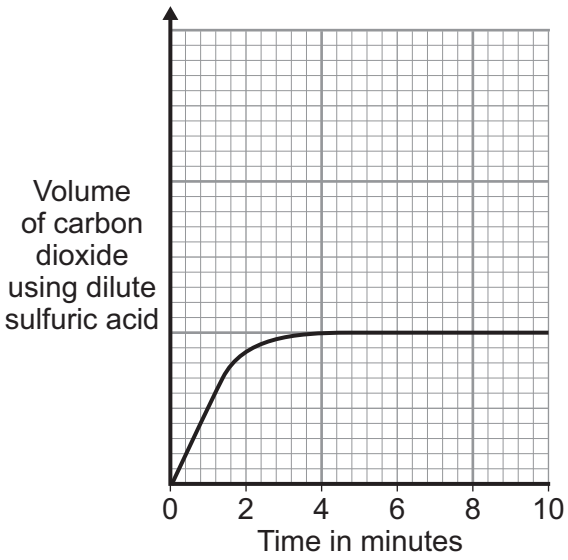
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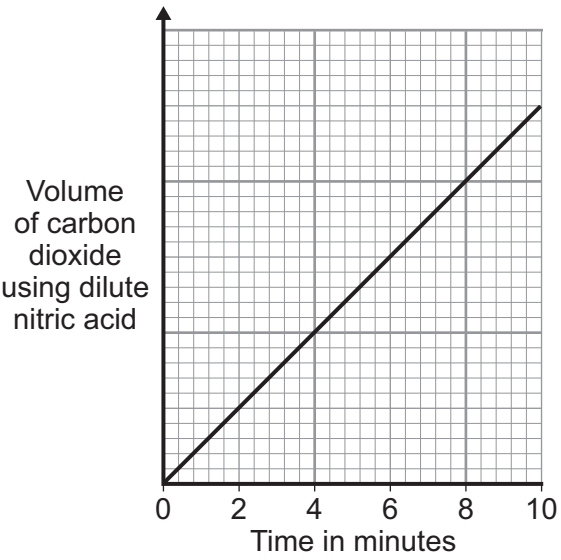
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(2 marks)

6 (b) Gases from vehicle exhausts produce sulfuric acid and nitric acid.

A student investigated the reaction of these two acids with calcium carbonate (limestone).
The type of acid was changed but all other variables were kept the same.
The student measured the volume of carbon dioxide produced each minute for a total of 10 minutes. He did this first for the reaction between dilute sulfuric acid and a cube of calcium carbonate (limestone).
The student repeated the experiment using dilute nitric acid in place of the dilute sulfuric acid.
The results are shown below.





4.9.3.1 Atmospheric pollutants from fuels

Question 55 · continued

6 (b) (i) State **two** variables that must be kept the same for this investigation.

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(2 marks)

6 (b) (ii) Reacting calcium carbonate with sulfuric acid gave different results to nitric acid.

The symbol equations for the reaction of calcium carbonate with sulfuric acid and with nitric acid are shown below.

$CaCO_3(s) + H_2SO_4(aq) \rightarrow CaSO_4(s) + H_2O(l) + CO_2(g)$

$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$

Describe how the results for sulfuric acid are different **and** use the symbol equations to explain this difference.

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(3 marks)

7

4.9.3.1 Atmospheric pollutants from fuels

Question 56

June 2012 | CH2HP | Original Q4 | Legacy

4 This question is about gold (Au).

4 (a) An atom of gold is represented as:

$$^{197}_{79}Au$$

How many neutrons are in this atom of gold? .....

(1 mark)

4 (b) Gold ions are used as a catalyst.

How does a gold atom (Au) become a gold ion (Au^{3+})?

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(2 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 56 · continued

4 (c) A gold catalyst can be used when carbon monoxide reacts with oxygen to make carbon dioxide.

4 (c) (i) Complete and balance the equation for this reaction.

..... CO + ... → ..... CO_2

(2 marks)

4 (c) (ii) Carbon dioxide has a very low boiling point.

Explain why.

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(3 marks)

4 (d) Gold is used as a catalyst in industrial processes. Gold is rare and increasingly expensive.

Suggest **three** reasons why gold is still used in industrial processes.

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(3 marks)

11

4.9.3.1 Atmospheric pollutants from fuels

Question 57

June 2012 | CH2HP | Original Q6 | Legacy

6 This question is about calcium hydroxide.

Ancient artworks and monuments can be protected from acid rain if the surface is sprayed with calcium hydroxide nanoparticles.



6 (a) Calcium hydroxide has the formula $Ca(OH)_2$

Why are there two hydroxide ions for each calcium ion in the formula?

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(1 mark)

6 (b) The calcium hydroxide is used in the form of *nanoparticles*.

What are *nanoparticles*?

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(1 mark)

4.9.3.1 Atmospheric pollutants from fuels

Question 57 · continued June 2012 | CH2HP | Original Q6 | Legacy

6 (c) A student added water to calcium oxide to make calcium hydroxide.

The equation for the reaction is shown below.

$$CaO + H_2O \rightarrow Ca(OH)_2$$

Calculate the maximum mass of calcium hydroxide which could be made from 2.00 g of calcium oxide.

Relative atomic masses (A_r): H = 1; O = 16; Ca = 40.

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Maximum mass of calcium hydroxide = ... g

(3 marks)

5

4.9.3.1 Atmospheric pollutants from fuels

Question 58

January 2013 | CH1HP | Original Q8 | Legacy

8 Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere may have evolved.

Titan is the largest moon of Saturn.

The table shows data about some substances in the atmosphere of Titan.

Substance	Melting point in °C	Boiling point in °C
Nitrogen	–210	–196
Methane	–183	–164
Argon	–189	–186
Hydrogen	–259	–253
Carbon monoxide	–205	–192

8 (a) There is no water on Titan. The average surface temperature on Titan is –179 °C.

Which of the substances in the table would form oceans on Titan?

Explain your answer.

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(2 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 58 · continued

8 (b) Amino acids are essential to life.

In the 1950s the Miller-Urey experiment showed that simple amino acids, such as glycine (NH_2CH_2COOH), could have been produced from the Earth's early atmosphere.

The Miller-Urey experiment showed that simple amino acids could be produced by reactions between hydrocarbons, ammonia and water.

Explain how the Miller-Urey experiment suggests that reactions between the substances in Titan's atmosphere could also produce simple amino acids.

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(4 marks)

6

4.9.3.1 Atmospheric pollutants from fuels

Question 59

June 2013 | CH1HP | Original Q7 | Legacy

7 There has been research into fuels for car engines.

Fuel	Content	Melting point in °C	Flashpoint in °C	Energy released in MJ per litre
Ethanol	C_2H_5OH	–114	+14	21.2
Diesel	hydrocarbons	About –24	+64	38.6
Petrol	hydrocarbons	About –57	–45	34.8
Rapeseed oil	fats	About +5	+130	32.8

The flashpoint is the lowest temperature a fuel vapour ignites in air.

7 (a) The melting point of ethanol is precise but the other melting points are approximate. Suggest why.

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(2 marks)

7 (b) Ethanol is produced by fermentation of sugar cane. Rapeseed oil is produced by pressing rapeseeds. Waste plant material from both processes is used to feed animals.

7 (b) (i) Describe how the process of fermentation is done.

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(2 marks)

7 (b) (ii) Carbon neutral fuels do **not** increase the amount of carbon dioxide in the atmosphere.

Suggest why using a biofuel, such as ethanol or rapeseed oil, is thought to be carbon neutral.

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(2 marks)

4.9.3.1 Atmospheric pollutants from fuels

Question 59 · continued

7 (c) When any fuel from the table is used in a car engine, the exhaust gases contain nitrogen oxides.

Explain why.

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(2 marks)

7 (d) Evaluate replacing petrol with ethanol as a fuel for cars.

To gain full marks you should give a justified conclusion.

Use the information from the table and your knowledge to answer this question.

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(4 marks)

12

4.9.3.1 Atmospheric pollutants from fuels

Question 60

June 2014 | CH1HP | Original Q1 | Legacy

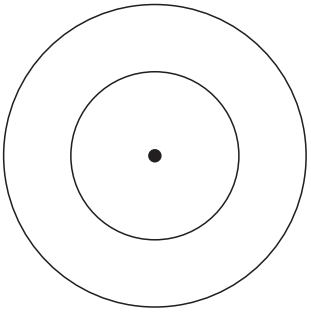
1 Fossil fuels contain carbon and hydrogen.

1 (a) (i) Use the Chemistry Data Sheet to help you to answer this question.

Complete **Figure 1** to show the electronic structure of a carbon atom.

[1 mark]

Figure 1



1 (a) (ii) Complete the word equation for the oxidation of hydrogen.

[1 mark]

hydrogen + oxygen ⟶ .....

1 (b) Coal is a fossil fuel.

Coal contains the elements hydrogen, sulfur, oxygen and carbon.

Name **two** products of burning coal that have an impact on the environment.

What impact does each of the products you named have on the environment?

[4 marks]

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4.9.3.1 Atmospheric pollutants from fuels

Question 61

June 2014 | CH1HP | Original Q2 | Legacy

2 Ethanol and vegetable oil are used as fuels.

2 (a) There are two different ways to produce ethanol:

- using ethene from crude oil
- using sugar from plants.

2 (a) (i) Ethanol is produced from ethene by **hydration** in the presence of a catalyst.

What is **hydration**?

[1 mark]

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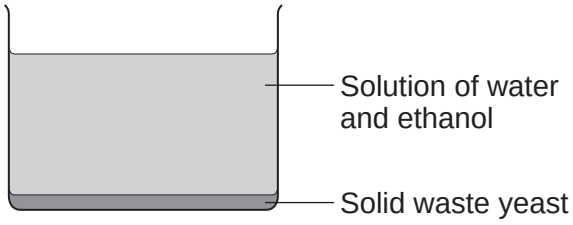
.....

2 (a) (ii) Fermentation is used to produce ethanol from sugar by:

- dissolving the sugar in water
- adding yeast to the sugar solution
- leaving the mixture for three days.

Figure 2 shows the substances after three days.

Figure 2



Suggest:

- how the solid waste yeast is removed
- how ethanol is obtained from the solution.

[2 marks]

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4.9.3.1 Atmospheric pollutants from fuels

Question 61 · continued

2 (b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Crude oil is separated to produce the fraction petroleum diesel.

Worries about low supplies of crude oil have led to the growing of large areas of crops to produce vegetable oil.

Vegetable oils are used to produce biodiesel.

There are economic, ethical and environmental issues about the use of biodiesel.

Biodiesel and petroleum diesel are used as a fuel for cars. In a car engine the fuel burns and releases waste products through the car exhaust system.

Table 1 shows the amount of waste products formed by biodiesel compared with the amount of waste products formed by petroleum diesel.

(Note that ppm is parts per million.)

Table 1

	Carbon dioxide in ppm	Nitrogen oxides in ppm	Sulfur dioxide in ppm	Particulates in g per m^3
Biodiesel	20 000	760	0	0.3
Petroleum diesel	80 000	700	300	0.6

Use this information and your knowledge and understanding to give advantages and disadvantages of using biodiesel instead of petroleum diesel.

[6 marks]

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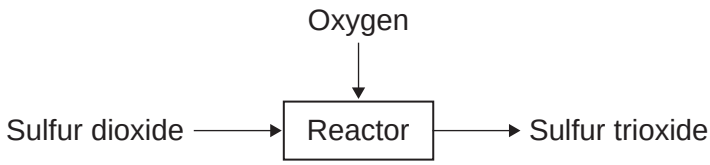
4.9.3.1 Atmospheric pollutants from fuels

Question 62

June 2014 | CH2HP | Original Q3 | Legacy

3 **Figure 2** represents a reaction in the production of sulfuric acid.

Figure 2



3 (a) Complete and balance the equation for the reaction.

[2 marks]

..... $SO_2(g)$ + ... (g) $\rightleftharpoons$ ..... $SO_3(g)$

3 (b) The conditions can affect the rate of the reaction.

3 (b) (i) The pressure of the reacting gases was increased.

State the effect of increasing the pressure on the rate of reaction.

Explain your answer in terms of particles.

[3 marks]

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4.9.3.1 Atmospheric pollutants from fuels

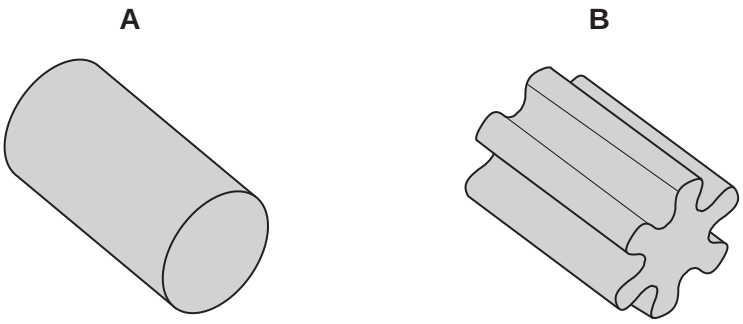
Question 62 · continued

3 (b) (ii) A catalyst is used for the reaction.

The gases pass through a layer containing pieces of the catalyst.

Figure 3 shows the shapes of pieces of catalyst.

Figure 3



Suggest and explain why shape **B** is more effective as a catalyst than shape **A**.

[2 marks]

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3 (c) The reaction is carried out at a high temperature to provide the reactants with the **activation energy**.

What is meant by the **activation energy**?

[1 mark]

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4.9.3.1 Atmospheric pollutants from fuels

Question 62 · continued

3 (d) Sulfuric acid reacts with metals to produce salts.

3 (d) (i) A student concluded that potassium would **not** be a suitable metal to react with sulfuric acid.

Explain why.

[2 marks]

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3 (d) (ii) A student reacted zinc metal with sulfuric acid to produce a salt and another product.

Complete the equation for this reaction.

[2 marks]

$Zn + H_2SO_4 \longrightarrow$ ..... + ...

3 (d) (iii) The student wanted to increase the rate of the reaction between the zinc and sulfuric acid.

State **one** way, other than using a catalyst, that the student could increase the rate of the reaction.

[1 mark]

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13

4.9.3.1 Atmospheric pollutants from fuels

Question 63

June 2015 | CH1HP | Original Q5 | Legacy

5 Crude oil is a fossil fuel.

5 (a) Describe how crude oil is separated into fractions.

[4 marks]

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5 (b) Fuel oil is one of the fractions from crude oil.

Power stations burn fuel oil to generate electricity. The waste gases from the combustion of fuel oil contain carbon dioxide, water vapour, sulfur dioxide and oxides of nitrogen.

The waste gases are passed through a suspension of limestone in water. Limestone is mainly calcium carbonate.

Suggest how the use of a suspension of limestone decreases one of the environmental impacts that the waste gases would cause.

[3 marks]

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4.9.3.1 Atmospheric pollutants from fuels

Question 63 · continued

5 (c) Some fractions from crude oil contain large hydrocarbon molecules.

5 (c) (i) Hydrocarbon molecules, such as decane, can be cracked to produce smaller, more useful molecules.

Write the correct formula of the third product to complete the chemical equation.

You do not need to give the name of this product.

[1 mark]

$C_{10}H_{22} \longrightarrow C_5H_{10} + C_3H_8 +$ .....

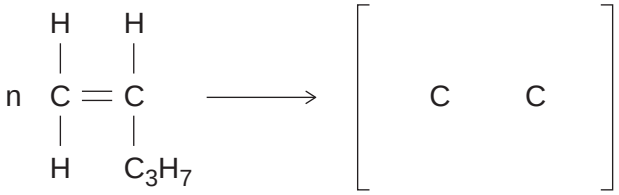
decane pentene propane

5 (c) (ii) Pentene is used to produce poly(pentene).

Complete the equation and the displayed structure of poly(pentene).

[3 marks]

Pentene **Poly(pentene)**



5 (c) (iii) Some polymers are described as smart polymers.

Suggest **one** property of a smart polymer that is different to that of an ordinary polymer.

[1 mark]

.....

.....

12

4.9.3.1 Atmospheric pollutants from fuels

Question 64

June 2016 | CH1HP | Original Q2 | Legacy

2 This question is about hydrocarbons.

2 (a) Most of the hydrocarbons in crude oil are alkanes.

2 (a) (i) Large alkane molecules can be cracked to produce more useful molecules.

The equation shows the cracking of dodecane.

$$\underset{\text{dodecane}}{C_{12}H_{26}} \longrightarrow \underset{\text{butane}}{C_4H_{10}} + \underset{\text{hexene}}{C_6H_{12}} + \underset{\text{ethene}}{C_2H_4}$$

Give **two** conditions used to crack large alkane molecules.

[2 marks]

1 _____

2 _____

2 (a) (ii) The products hexene and ethene are alkenes.

Complete the sentence.

[1 mark]

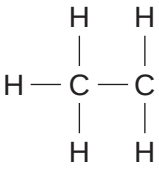
When alkenes react with bromine water the colour changes

from orange to _____ .

2 (a) (iii) Butane (C_4H_{10}) is an alkane.

Complete the displayed structure of butane.

[1 mark]



Question 2 continues on the next page

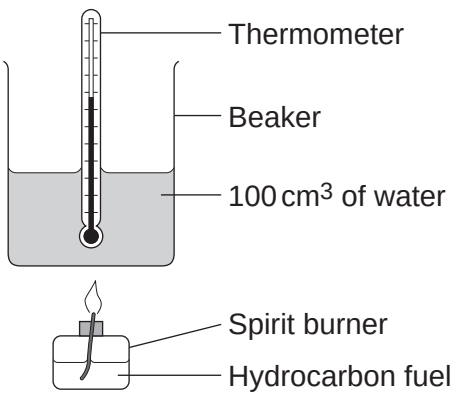
4.9.3.1 Atmospheric pollutants from fuels

Question 64 · continued

2 (b) A group of students investigated the energy released by the combustion of four hydrocarbon fuels.

Figure 3 shows the apparatus used.

Figure 3



Each hydrocarbon fuel was burned for two minutes.

Table 1 shows the students' results.

Table 1

	After two minutes				
Name and formula of hydrocarbon fuel	**Mass of fuel used in g**	**Temperature increase of water in °C**	**Energy released by fuel in kJ**	**Energy released by 1.0 g of fuel in kJ**	**Relative amount of smoke in the flame**
Hexane, C_6H_{14}	0.81	40	16.80	20.74	very little smoke
Octane, C_8H_{18}	1.10	54	22.68	20.62	some smoke
Decane, $C_{10}H_{22}$	1.20	58	24.36		smoky
Dodecane, $C_{12}H_{26}$	1.41	67	28.14	19.96	very smoky

4.9.3.1 Atmospheric pollutants from fuels

Question 64 · continued

2 (b) (i) Calculate the energy released by 1.0 g of decane in kJ.

[2 marks]

Energy released = _____ kJ

2 (b) (ii) Suggest **one** improvement to the apparatus, or the use of the apparatus, that would make the temperature increase of the water for each fuel more accurate.

Give a reason why this is an improvement.

[2 marks]

2 (b) (iii) The students noticed that the bottom of the beaker became covered in a black substance when burning these fuels.

Name this black substance.

Suggest why it is produced.

[2 marks]

2 (b) (iv) A student concluded that hexane is the best of the four fuels.

Give **two** reasons why the results in **Table 1** support this conclusion.

[2 marks]

1 _____

2 _____

Question 2 continues on the next page

4.9.3.1 Atmospheric pollutants from fuels

Question 64 · continued

2 (c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Most car engines use petrol as a fuel.

- Petrol is produced from the fractional distillation of crude oil.
- Crude oil is a mixture of hydrocarbons.
- Sulfur is an impurity in crude oil.

Car engines could be developed to burn hydrogen as a fuel.

- Hydrogen is produced from natural gas.
- Natural gas is mainly methane.

Table 2 shows information about petrol and hydrogen.

Table 2

	Petrol	**Hydrogen**
State of fuel at room temperature	Liquid	Gas
Word equation for combustion of the fuel	petrol + oxygen ⟶ carbon dioxide + water	hydrogen + oxygen ⟶ water
Energy released from combustion of 1 g of the fuel	47 kJ	142 kJ

Describe the **advantages** and **disadvantages** of using hydrogen instead of petrol in car engines.

Use the information given and your knowledge and understanding to answer this question.

[6 marks]

4.9.3.1 Atmospheric pollutants from fuels

Question 65

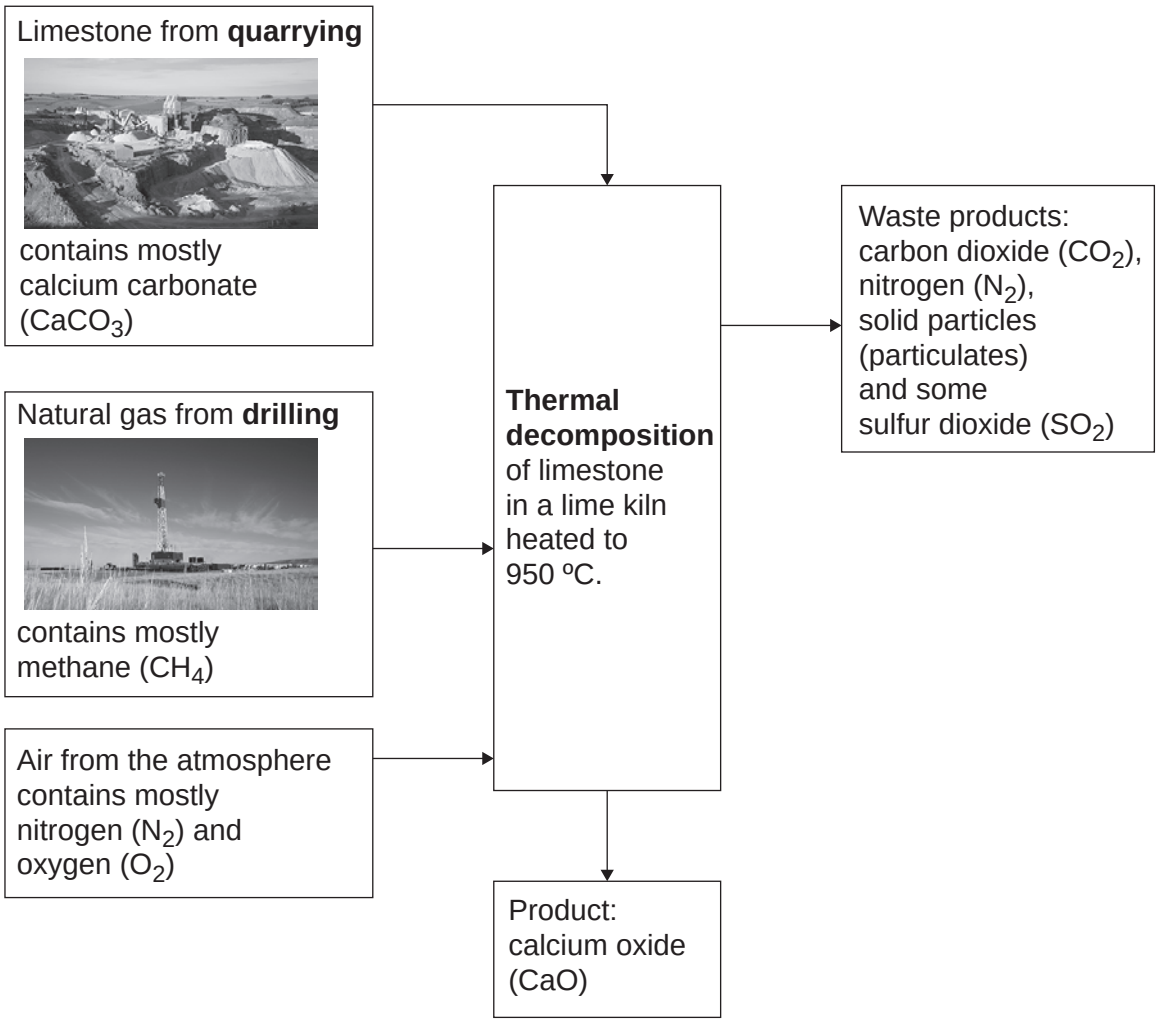
June 2017 | CH1HP | Original Q3 | Legacy

3 **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Limestone is heated in a lime kiln to produce calcium oxide.

Figure 4 shows the reactants used and the products made in a lime kiln.

Figure 4



Use information from **Figure 4** to explain the potential environmental impacts of quarrying, drilling and the thermal decomposition of limestone used in the production of calcium oxide.

[6 marks]

4.9.3.1 Atmospheric pollutants from fuels

Question 66

June 2017 | CH1HP | Original Q5 | Legacy

5 This question is about the Earth's atmosphere.

5 (a) The Earth's early atmosphere was a mixture of gases.

One theory is that the Earth's early atmosphere had the composition shown in **Table 4**.

Table 4

Gas	Percentage in Earth's early atmosphere (%)
Carbon dioxide	96
Nitrogen	3.5
Oxygen	a trace
Other gases including methane, ammonia, hydrogen and water vapour	0.5

5 (a) (i) Amino acids are at the basis of all life processes.
The simplest amino acid is glycine, NH_2CH_2COOH

Two scientists, Miller and Urey, showed that they could produce glycine from a mixture of methane, ammonia, hydrogen and water.
Miller and Urey concluded that this is how life was formed on Earth.

Suggest **one** reason why this conclusion may **not** be correct.

[1 mark]

5 (a) (ii) Give **three** reasons why the percentage of carbon dioxide in the Earth's atmosphere today is less than the percentage of carbon dioxide in the Earth's early atmosphere.

[3 marks]

4.9.3.1 Atmospheric pollutants from fuels

Question 66 · continued

5 (b) **Table 5** shows the boiling points of some gases in the air.

Table 5

Gas	Boiling point in °C
Nitrogen	–196
Oxygen	–183
Carbon dioxide	–79*
Helium	–269
Neon	–246
Argon	–186

*freezes at this temperature

Oxygen from the air is separated by fractional distillation. To do this separation the air is cooled to –200 °C. Most of the gases condense.

5 (b) (i) Name the two gases that would **not** condense at –200 °C.

[1 mark]

_____ and _____

5 (b) (ii) Suggest why carbon dioxide is removed before the air is cooled.

[1 mark]

_____

_____

5 (b) (iii) The liquid at –200 °C is passed into a fractionating column.

Explain why one of the fractions is a mixture of oxygen and one other gas.

[2 marks]

_____

_____

_____

_____

4.9.3.1 Atmospheric pollutants from fuels

Question 66 · continued

5 (c) Oxygen is used in the production of steel.

Cast iron from a blast furnace contains 96% iron and 4% carbon.

The stages for the production of steel from cast iron are:

Stage 1 pass oxygen into molten cast iron

Stage 2 add small amounts of other metals.

Explain why each stage is needed in the production of steel.

[4 marks]

12

4.9.3.1 Atmospheric pollutants from fuels

Question 67

June 2018 | 8462/2H | Original Q7

0 7 Older cars are tested each year to measure the amount of pollutants contained in exhaust fumes.

Table 4 shows the maximum allowed percentages of exhaust pollutants for petrol cars.

Table 4

Age of car in years	Maximum allowed percentage (%) of exhaust pollutant	
	Carbon monoxide	Unburned hydrocarbons
16–24	0.30	0.02
3–16	0.20	0.02

0 7 . 1 Explain how carbon monoxide is produced when petrol is burned in car engines.

[2 marks]

0 7 . 2 Suggest **two** reasons why the maximum allowed percentage of carbon monoxide has been decreased for newer cars.

[2 marks]

1

2

4.9.3.1 Atmospheric pollutants from fuels

Question 67 · continued

0 7 . 3 Give **one** reason for having a maximum allowed percentage of unburned hydrocarbons in exhaust fumes.

[1 mark]

Oxides of nitrogen are also pollutants contained in exhaust fumes.

0 7 . 4 Describe how oxides of nitrogen are produced when petrol is burned in car engines.

[2 marks]

Catalytic converters are fitted to car exhausts to reduce the amount of pollutants released into the atmosphere.

0 7 . 5 Nitrogen dioxide is an oxide of nitrogen.

Nitrogen dioxide reacts to produce nitrogen and oxygen in catalytic converters.

Complete the equation for this reaction.

The equation should be balanced.

[2 marks]

$$___\ NO_2\ (g) \rightarrow _____ + ___\ O_2\ (g)$$

4.9.3.1 Atmospheric pollutants from fuels

Question 67 · continued

0 7 . 6 Give **two** effects of atmospheric pollution which are reduced by using catalytic converters.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 7 The catalyst in catalytic converters is a mixture of three elements.

Where in the periodic table are these elements most likely to be found?

[1 mark]

Tick **one** box.

- Alkali metals ☐
- Halogens ☐
- Noble gases ☐
- Transition metals ☐

12

4.9.3.1 Atmospheric pollutants from fuels

Question 68

June 2018 | 8462/2H | Original Q9

0 9 This question is about methanol.

0 9 . 1 Methanol is broken down in the body during digestion.

What type of substance acts as a catalyst in this process?

[1 mark]

Tick **one** box.

- Amino acid ☐
- Enzyme ☐
- Ester ☐
- Nucleotide ☐

In industry, methanol is produced by reacting carbon monoxide with hydrogen.

The equation for the reaction is:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

0 9 . 2 How many moles of carbon monoxide react completely with 4.0×10^3 moles of hydrogen?

[1 mark]

Tick **one** box.

- 1.0×10^3 moles ☐
- 2.0×10^3 moles ☐
- 4.0×10^3 moles ☐
- 8.0×10^3 moles ☐

4.9.3.1 Atmospheric pollutants from fuels

Question 68 · continued

0 9 . 3 The reaction is carried out at a temperature of 250 ºC and a pressure of 100 atmospheres.

The forward reaction is exothermic.

Explain what happens to the yield of methanol if a temperature higher than 250 ºC is used.

[2 marks]

0 9 . 4 A pressure of 100 atmospheres is used instead of atmospheric pressure.

The higher pressure gives a greater yield of methanol **and** an increased rate of reaction.

Explain why.

[4 marks]

Question 9 continues on the next page

4.9.3.1 Atmospheric pollutants from fuels

Question 68 · continued

A catalyst is used in the reaction to produce methanol from carbon monoxide and hydrogen.

0 9 . 5 Explain how a catalyst increases the rate of a reaction.

[2 marks]

0 9 . 6 Suggest why a catalyst is used in this industrial process.

Do **not** give answers in terms of increasing the rate of reaction.

[1 mark]

0 9 . 7 Suggest the effect of using the catalyst on the equilibrium yield of methanol.

[1 mark]

12

4.9.3.1 Atmospheric pollutants from fuels

Question 69

June 2019 | 8462/2H | Original Q5

0 5 This question is about combustion of fuels.

0 5 . 1 Some central heating boilers use wood as a fuel.

Suggest **two** reasons why wood is more sustainable than natural gas as a fuel for central heating boilers.

[2 marks]

1 _____

_____

2 _____

_____

Natural gas is mainly methane.

When methane burns it can produce both carbon monoxide and carbon dioxide.

0 5 . 2 Explain the process by which carbon monoxide can be produced when methane is burned.

[2 marks]

_____

_____

_____

_____

0 5 . 3 Balance the equation for the combustion of methane to produce carbon monoxide.

[1 mark]

$$___\ CH_4(g) + ___\ O_2(g) \rightarrow ___\ CO(g) + ___\ H_2O(l)$$

4.9.3.1 Atmospheric pollutants from fuels

Question 69 · continued

June 2019 | 8462/2H | Original Q5

0 5 . 4 Propane burns to form carbon dioxide and water.

The equation for the reaction is:

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

3.60 dm^3 carbon dioxide is produced when a sample of propane is burned in 7.25 dm^3 oxygen.

Calculate the volume of unreacted oxygen.

Give your answer in cm^3

[4 marks]

Volume of unreacted oxygen = _____ cm^3

9

4.9.3.1 Atmospheric pollutants from fuels

Question 70

June 2019 | 8462/2H | Original Q10

1 0 This question is about reversible reactions and equilibrium.

Hydrogen is used to produce ammonia in the Haber process.

The hydrogen is made in two stages.

Stage 1 is the reaction of methane and steam to produce carbon monoxide and hydrogen.

The equation for the reaction is:

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

1 0 . 1 Calculate the atom economy for the formation of hydrogen in **stage 1**.

Relative atomic masses (A_r): H = 1 C = 12 O = 16

[2 marks]

Atom economy = _____ %

4.9.3.1 Atmospheric pollutants from fuels

Question 70 · continued

1 0 . 2 Explain why a low pressure is used in **stage 1**.

Give your answer in terms of equilibrium.

[2 marks]

1 0 . 3 **Stage 2** uses the carbon monoxide produced in **stage 1**.

The carbon monoxide is reacted with more steam to produce carbon dioxide and more hydrogen.

The equation for the reaction in **stage 2** is:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

What is the effect of increasing the pressure on the equilibrium yield of hydrogen in **stage 2**?

[1 mark]

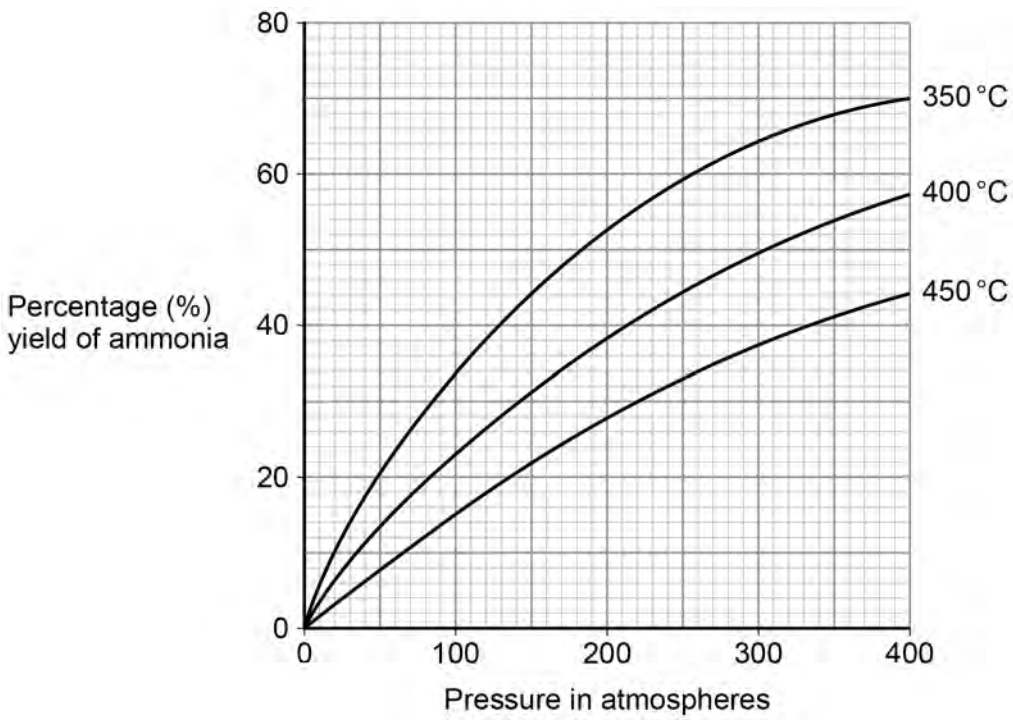
Question 10 continues on the next page

4.9.3.1 Atmospheric pollutants from fuels

Question 70 · continued

Figure 10 shows the percentage yield of ammonia produced at different temperatures and pressures in the Haber process.

Figure 10



A temperature of 450 °C and a pressure of 200 atmospheres are used in the Haber process.

1 0 . 4 A student suggested that a temperature of 350 °C and a pressure of 285 atmospheres could be used instead of those used in the Haber process.

Determine how many times greater the percentage yield of ammonia obtained would be.

Use **Figure 10**.

[3 marks]

Percentage yield = _____ times greater

4.9.3.1 Atmospheric pollutants from fuels

Question 70 · continued

June 2019 | 8462/2H | Original Q10

10.5 A pressure of 285 atmospheres is **not** used in the Haber process instead of 200 atmospheres.

Give **one** reason why.

[1 mark]

10.6 How does **Figure 10** show that the forward reaction in the Haber process is exothermic?

[1 mark]

10.7 World production of ammonia is now about 30 times greater than it was in 1950.

Suggest why the demand for ammonia has increased.

[2 marks]

12

4.9.3.1 Atmospheric pollutants from fuels

Question 71

November 2020 | 8462/2H | Original Q6

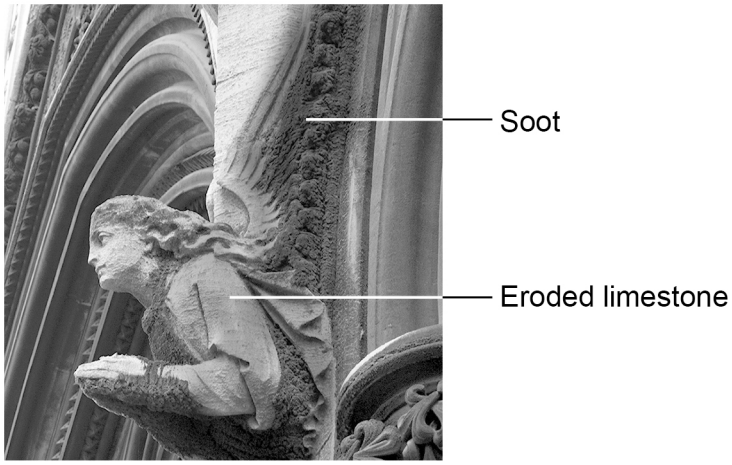
0 6 This question is about atmospheric pollution.

Figure 3 shows a limestone carving which has been damaged by atmospheric pollution.

The carving has been:

- blackened by soot
- eroded where the limestone has reacted with atmospheric pollutants.

Figure 3



0 6 . 1 Explain why soot is formed when some fossil fuels are burned.

[2 marks]

4.9.3.1 Atmospheric pollutants from fuels

Question 71 · continued

0 6 . 2 Fossil fuels are burned in car engines.

Explain how reducing the amount of sulfur in fossil fuels reduces the erosion of limestone.

[4 marks]

0 6 . 3 Oxides of nitrogen are atmospheric pollutants which are formed in car engines.

Explain why oxides of nitrogen are formed in car engines.

[2 marks]

8

4.9.3.1 Atmospheric pollutants from fuels

Question 72

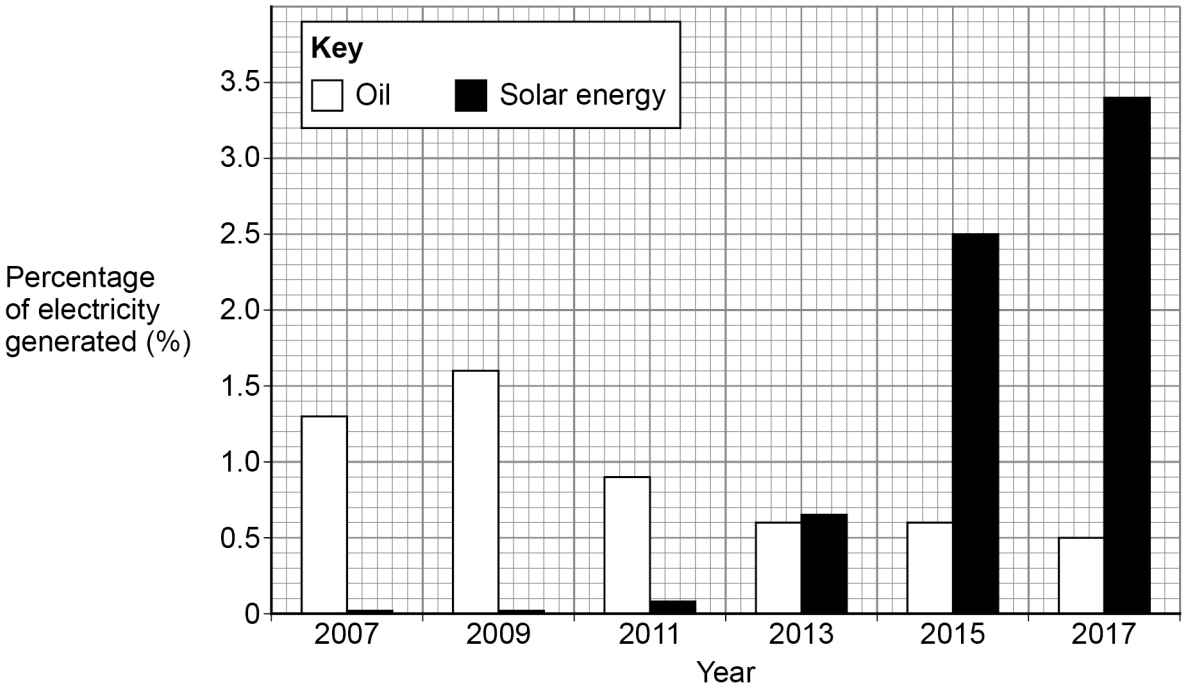
November 2021 | 8462/2H | Original Q1

0 1 This question is about fuels and energy.

Figure 1 shows the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Figure 1



0 1 . 1 Describe the changes in the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Use data from **Figure 1** in your answer.

[3 marks]

4.9.3.1 Atmospheric pollutants from fuels

Question 72 · continued

0 1 . 2 Oil contains carbon and some sulfur.

When oil is burned, the products of combustion may be released into the atmosphere.

Explain the environmental effects of releasing these products of combustion into the atmosphere.

[6 marks]

4.9.3.1 Atmospheric pollutants from fuels

Question 72 · continued

0 1 . 3 Suggest **one** reason why using solar energy is a more sustainable way of generating electricity than burning oil.

[1 mark]

0 1 . 4 Solar energy may **not** be able to replace the generation of electricity from fossil fuels completely.

Suggest **two** reasons why.

[2 marks]

1 _____

2 _____

12

4.9.3.1 Atmospheric pollutants from fuels

Question 73

June 2024 | 8462/2H | Original Q5

0 5 This question is about burning fuels in central heating boilers.

In the future, gas central heating boilers may burn hydrogen rather than natural gas.

Table 2 shows information about these fuels when 1 dm^3 of the fuel is burned in a central heating boiler.

Table 2

	Fuel	
	Hydrogen	**Natural gas**
Energy released in kJ	11.9	37.1
Mass of carbon dioxide produced in grams	0.00	1.83
Mass of water vapour produced in grams	0.75	1.50
Mass of oxides of nitrogen produced in grams	6.6×10^{-4}	4.9×10^{-4}

0 5 . 1 Explain how oxides of nitrogen are produced when burning fuels.

[2 marks]

4.9.3.1 Atmospheric pollutants from fuels

Question 73 · continued

0 5 . 2 Explain **one** positive impact on the environment of burning hydrogen rather than natural gas as a fuel.

Use **Table 2**.

[2 marks]

0 5 . 3 Explain **one** negative impact on the environment of burning hydrogen rather than natural gas as a fuel.

Use **Table 2**.

[2 marks]

Question 5 continues on the next page

4.9.3.1 Atmospheric pollutants from fuels

Question 73 · continued

0 5 . 4 Air is 20% oxygen.

Calculate the volume of air needed to provide enough oxygen to react with 3.50 dm^3 of hydrogen gas.

The equation for the reaction is

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

[3 marks]

Volume of air = _____ dm^3

0 5 . 5 Central heating boilers can also burn kerosene.

Kerosene is produced from crude oil in a fractionating column using fractional distillation.

In the first step, crude oil is heated and hydrocarbon vapours are formed.

Explain how kerosene is produced from these hydrocarbon vapours.

[3 marks]

12

4.9.3.1 Atmospheric pollutants from fuels

Question 74

June 2024 | 8462/2H | Original Q7

0 7 This question is about sulfuric acid.

0 7 . 1 Sulfuric acid contains sulfate ions.

Describe the test for the presence of sulfate ions in sulfuric acid.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

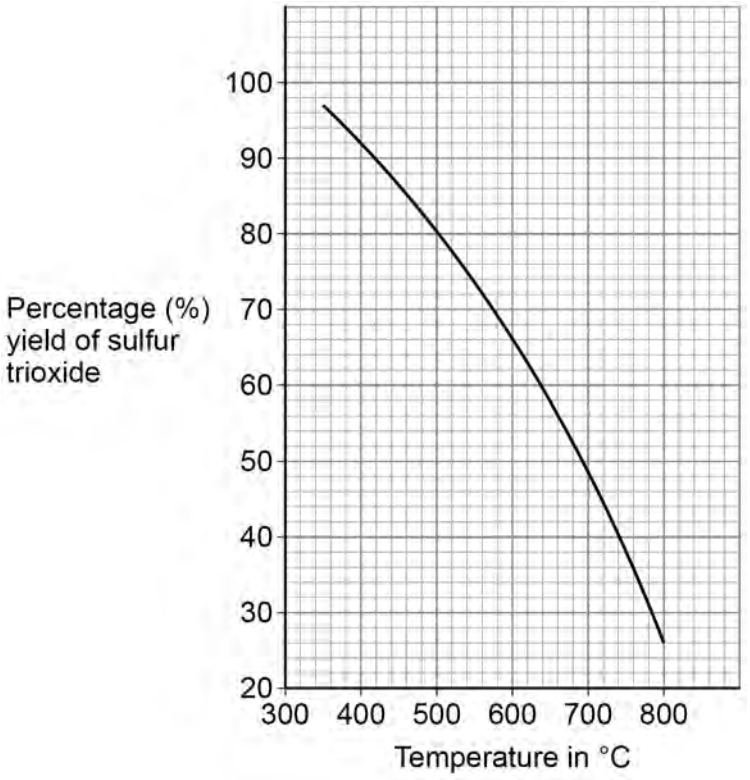
_____

One stage in the industrial production of sulfuric acid is the reaction of sulfur dioxide with oxygen to produce sulfur trioxide.

This reversible reaction reaches dynamic equilibrium.

Figure 7 shows the percentage yield of sulfur trioxide in this reaction at different temperatures.

Figure 7



4.9.3.1 Atmospheric pollutants from fuels

Question 74 · continued

0 7 . 2 Which statement about the forward reaction is correct?

Use **Figure 7**.

[1 mark]

Tick (✓) **one** box.

- The yield is greater at higher temperatures because the reaction is exothermic. ☐
- The yield is greater at higher temperatures because the reaction is endothermic. ☐
- The yield is smaller at higher temperatures because the reaction is exothermic. ☐
- The yield is smaller at higher temperatures because the reaction is endothermic. ☐

The equation for the reaction is:

$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$$

0 7 . 3 Explain why the percentage yield of sulfur trioxide in this reaction is greater if the pressure is higher.

[2 marks]

0 7 . 4 In industry, the reaction is done at 450 °C and atmospheric pressure.

Under these conditions the yield of sulfur trioxide is 86%.

Suggest **two** reasons why a higher pressure is **not** used.

[2 marks]

1

2

4.9.3.1 Atmospheric pollutants from fuels

Question 74 · continued

0 7 . 5 This reaction uses a catalyst to increase the rate of the reaction.

The catalyst is a metal oxide.

Which is the most likely metal in the metal oxide catalyst?

Use the periodic table.

[1 mark]

Tick (✓) **one** box.

Aluminium (Al) ☐

Barium (Ba) ☐

Potassium (K) ☐

Vanadium (V) ☐

8