Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

General Certificate of Secondary Education
Foundation Tier and Higher Tier
November 2011

Science A

Unit Chemistry C1a (Products from Rocks)

Chemistry

Unit Chemistry C1a (Products from Rocks)

CHY1AP

F&H

Tuesday 15 November 2011 Morning Session

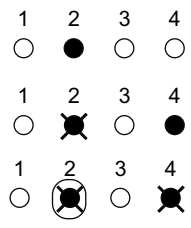
For this paper you must have:
- a black ball-point pen
- an objective test answer sheet.

You may use a calculator.

Time allowed
- 30 minutes

Instructions
- Fill in the boxes at the top of this page.
- Check that your name, candidate number and centre number are printed on the separate answer sheet.
- Check that the separate answer sheet has the title 'Chemistry Unit 1a' printed on it.
- Attempt **one Tier only**, **either** the Foundation Tier **or** the Higher Tier.
- Make sure that you use the correct side of the separate answer sheet; the Foundation Tier is printed on one side and the Higher Tier on the other.
- Answer **all** the questions for the Tier you are attempting.
- Record your answers on the separate answer sheet only.
- Do all rough work in this book, **not** on your answer sheet.

Instructions for recording answers
- Use a **black ball-point pen**.
- For each answer **completely fill in the circle** as shown.
- Do **not** extend beyond the circles.
- If you want to change your answer, **you must** cross out your original answer, as shown.
- If you change your mind about an answer you have crossed out and now want to choose it, draw a ring around the cross as shown.



Information
- The maximum mark for this paper is 36.

Advice
- Do **not** choose more responses than you are asked to. You will lose marks if you do.
- Make sure that you hand in both your answer sheet and this question paper at the end of the test.
- If you start to answer on the wrong side of the answer sheet by mistake, make sure that you cross out **completely** the work that is not to be marked.

You must do **one Tier** only, **either** the Foundation Tier **or** the Higher Tier.
The Higher Tier starts on page 16 of this booklet.

FOUNDATION TIER

Section One

Questions **ONE** to **FIVE**.

In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1–4**.

Use **each** answer only **once**.

Mark your choices on the answer sheet.

QUESTION ONE

This question is about iron and steel.

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

A hard

B resistant to corrosion

C easily shaped

D brittle

Iron from the blast furnace has few uses because it is . . . **1** . . . .

Low-carbon steel is used to make car body panels because it is . . . **2** . . . .

High-carbon steel is used to make knives because it is . . . **3** . . . .

Stainless steel is used to make kitchen sinks because it is . . . **4** . . . .

QUESTION TWO

The table shows information about four copper ores, **A**, **B**, **C** and **D**.

Hardness is measured on a scale of 1 (softest) to 10 (hardest).

	Ore	Density in g per cm^3	Hardness	Formula of the copper compound in the ore	Percentage (%) of copper in the copper compound
A	Chalcocite	5.5–5.7	2.5–3.0	Cu_2S	79.9
B	Chalcopyrite	4.1–4.3	3.5–4.0	$CuFeS_2$	34.5
C	Cuprite	5.8–6.1	3.5–4.0	Cu_2O	88.8
D	Malachite	3.9–4.0	3.5–4.0	$CuCO_3.Cu(OH)_2$	57.3

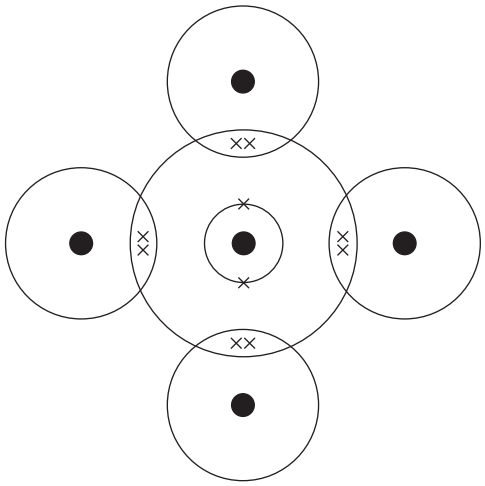
Match ores, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table below.

1	It contains the smallest percentage of copper.
2	It is the softest.
3	It has the largest range of density.
4	It has four elements in its formula.

Turn over for the next question

QUESTION THREE

The diagram shows how a carbon atom can be joined to four atoms of hydrogen to form methane.



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

A a bond

B an electron

C a molecule

D a nucleus

In the diagram, each ● represents . . . **1** . . . and each × represents . . . **2** . . . .

The carbon atom is joined to each hydrogen atom by . . . **3** . . . .

This forms . . . **4** . . . of methane.

QUESTION FOUR

The table shows some information about four alkanes, **A**, **B**, **C** and **D**.

	Name of alkane	Formula of alkane	Melting point in °C	Boiling point in °C	Amount of oxygen, in cm^3, needed to completely burn 100 cm^3 of the alkane
A	Methane	CH_4	–182	–164	200
B	Ethane	C_2H_6	–183	–89	350
C	Propane	C_3H_8	–190	–42	500
D	Butane	C_4H_{10}	–138	–1	650

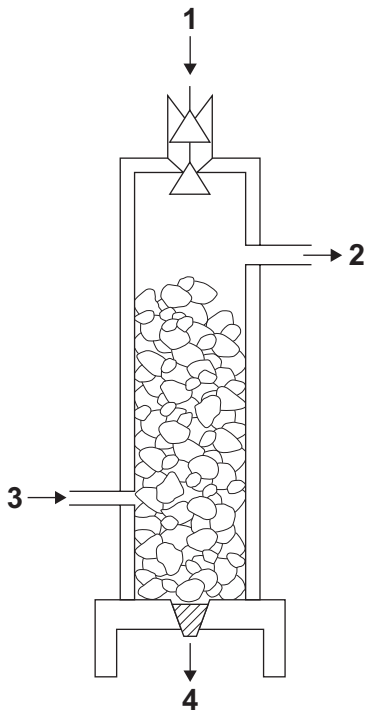
Match alkanes, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table below.

1	This alkane has the lowest melting point.
2	This alkane has the smallest molecules.
3	The boiling point of this alkane is similar to the melting point of ice.
4	10 cm^3 of this alkane requires 35 cm^3 of oxygen to burn completely.

Turn over for the next question

QUESTION FIVE

The diagram shows a limestone kiln that is used to produce quicklime from limestone.



Match substances, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagram.

A Carbon dioxide

B Methane and hot air

C Limestone

D Quicklime

Turn over for the next question

Section Two

Questions **SIX** to **NINE**.

Each of these questions has four parts.

In each part choose only **one** answer.

Mark your choices on the answer sheet.

QUESTION SIX

This question is about the viscosity of engine oils.

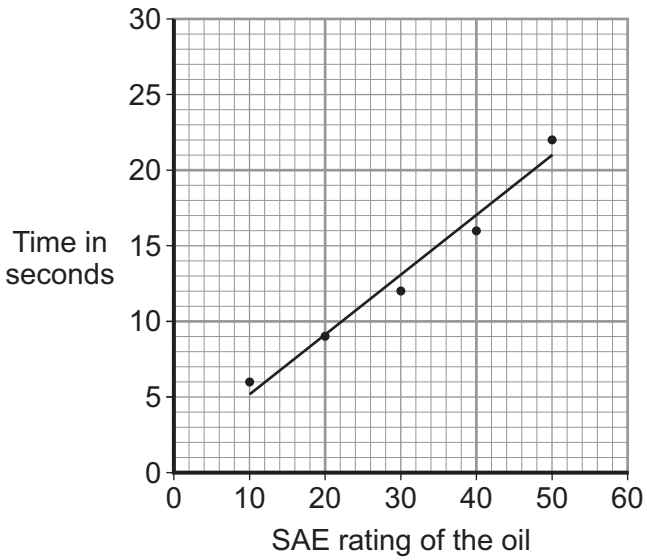
Viscosity is a measure of how easily a liquid will flow.
The less viscous a liquid is, the more easily it will flow.
The viscosities of engine oils are given a rating by the Society of Automotive Engineers (SAE rating).

A student investigated the viscosity of oils with different SAE ratings. She poured a fixed volume of an oil of SAE 10 into a funnel with a narrow spout and started a stopwatch. She measured how long it took for all of the oil to flow out of the funnel.

She repeated the experiment with four different oils.

Here are her results.

SAE rating	Time in seconds
10	6
20	9
30	12
40	16
50	22



6A The experiment shows that . . .

1 an SAE 15 oil would take 15 seconds to flow through the funnel.

2 the SAE 40 oil takes twice as long to flow through the funnel as SAE 20 oil.

3 all five oils have a similar viscosity.

4 viscosity increases as the SAE rating increases.

6B The reliability of the results could be improved . . .

1 by using a larger funnel.

2 by repeating each test.

3 by using a smaller volume of oil.

4 by using oils with lower SAE ratings.

6C Three months later, the student did the same experiment in the same laboratory, using samples of the same oils.

She found that all the oils took longer to flow through the funnel.

This could be because . . .

1 long oil molecules break into shorter ones when they are stored.

2 the laboratory was at a lower temperature.

3 she had used a funnel with a wider spout.

4 she started the stopwatch only when the oil started to drip out.

6D The student was unsure about the trend shown by the line of best fit through her points.

This is because . . .

1 a curve passing through all the points is always better than a straight line.

2 the points on her graph were plotted incorrectly.

3 none of the points lies on the line.

4 she did not have enough oils to show whether the line should be curved or straight.

QUESTION SEVEN

National Parks are large, attractive areas where people can enjoy the countryside.

In one particular National Park, a company has a large limestone quarry and a cement factory close to it. There is a village about one kilometre from the cement factory.

7A Although the quarry is a scar on the landscape and increases pollution in the area, local people gain some benefit because . . .

1 it provides a new recreational area.

2 it creates a new habitat for wildlife.

3 it provides employment.

4 it attracts tourists to the area.

7B The main advantage to the company of having a cement factory close to the quarry rather than many kilometres away is that . . .

1 the factory can be operated 365 days a year.

2 transport costs will be less.

3 visual pollution near the village will be minimised.

4 there will be less atmospheric pollution near the village.

Local people are concerned that a different fuel being used at the cement factory is releasing sulfur dioxide when it is burned.

The table shows the sulfur dioxide concentration in the atmosphere, recorded on one day.

Distance from the cement factory in metres	Concentration of sulfur dioxide in parts per million
0	65
500	48
1000	16
1500	10
2000	5

7C The conclusion from these results is that . . .

1 as the distance in metres doubles, the concentration of the sulfur dioxide is halved.

2 the concentration of sulfur dioxide is lower further away from the cement factory.

3 children should not play within 1000 metres of the cement factory.

4 there is no sulfur dioxide 4000 metres from the cement factory.

7D On another day later in the year, the sulfur dioxide concentrations in the atmosphere were measured at the same places.

The concentrations were much lower.

Which of the following is the most likely reason for this change?

1 an increase in wind speed

2 an increase in cement production

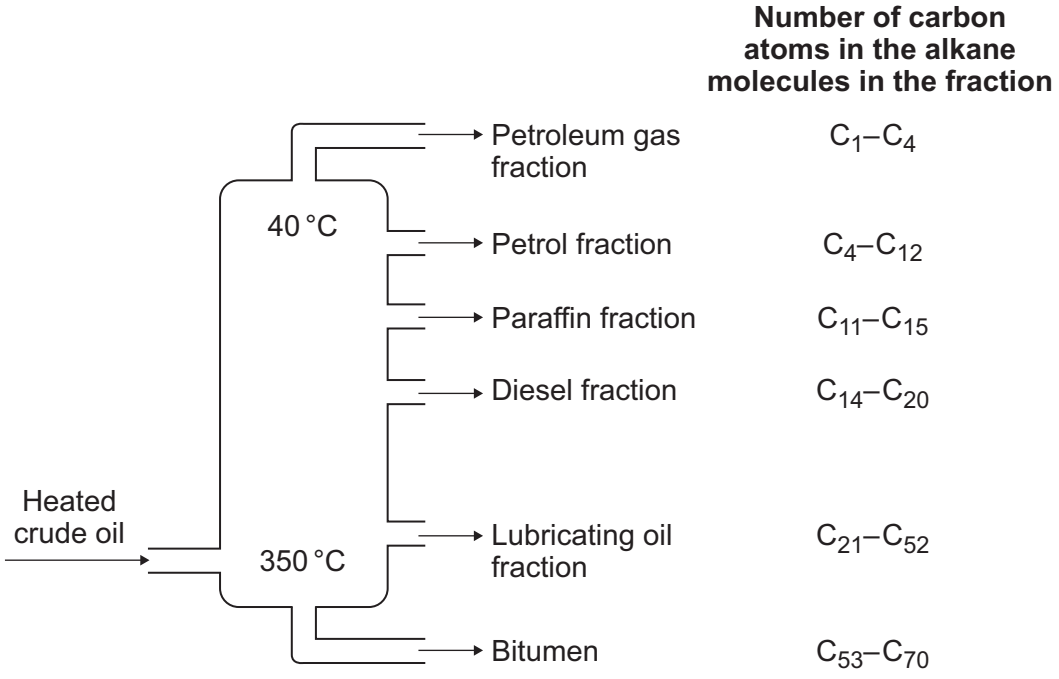
3 the factory using a fuel with a higher sulfur content

4 less rain when measurements were taken

QUESTION EIGHT

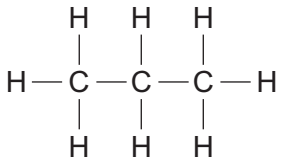
Crude oil can be separated into fractions.

Each fraction contains several alkanes.



8A One of the alkanes in the petrol fraction can be represented by . . .

1



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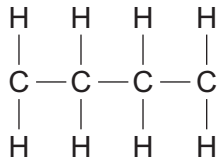

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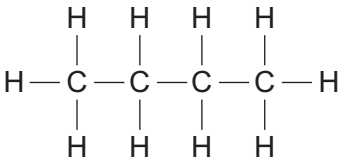
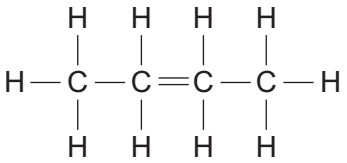


4



8B 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.

8C 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

8D Which of these gases **cannot** be produced when a pure alkane burns?

1 carbon monoxide

2 carbon dioxide

3 sulfur dioxide

4 water vapour

Turn over for the next question

QUESTION NINE

Iron oxide can be reduced to iron by mixing the oxide with carbon and heating strongly.

Aluminium oxide cannot be reduced to aluminium in this way. Aluminium is obtained from aluminium oxide by electrolysis.

9A Why is it possible to obtain iron but not aluminium by carbon reduction?

1 Iron is more reactive than aluminium.

2 Carbon is more reactive than aluminium but less reactive than iron.

3 Carbon is more reactive than iron but less reactive than aluminium.

4 Aluminium and iron are both more reactive than carbon.

9B The extraction of aluminium by electrolysis is an expensive process because . . .

1 aluminium easily corrodes in air.

2 a large amount of energy is needed.

3 aluminium oxide is difficult to mine.

4 aluminium reacts with carbon.

9C As electrolysis is expensive, an increasing amount of aluminium is being recycled.

Another important reason to recycle aluminium is that . . .

1 it saves limited aluminium oxide reserves.

2 the recycled aluminium is purer.

3 aluminium scrap does not corrode easily.

4 recycling aluminium does not use energy.

9D Which two of the following statements could explain why aluminium is preferred to iron for making cans for drinks?

W Aluminium has a lower density than iron.

X Aluminium is a better conductor than iron.

Y Aluminium corrodes less easily than iron.

Z Aluminium is not as strong as iron.

1 **W** and **X**

2 **W** and **Y**

3 **X** and **Y**

4 **Y** and **Z**

END OF TEST

You must do **one Tier** only, **either** the Foundation Tier **or** the Higher Tier.
The Foundation Tier is earlier in this booklet.

HIGHER TIER

Section One

Questions **ONE** and **TWO**.

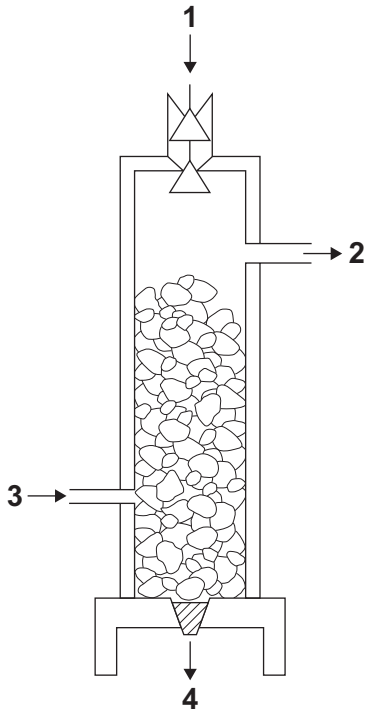
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1–4**.

Use **each** answer only **once**.

Mark your choices on the answer sheet.

QUESTION ONE

The diagram shows a limestone kiln that is used to produce quicklime from limestone.



Match substances, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagram.

A Carbon dioxide

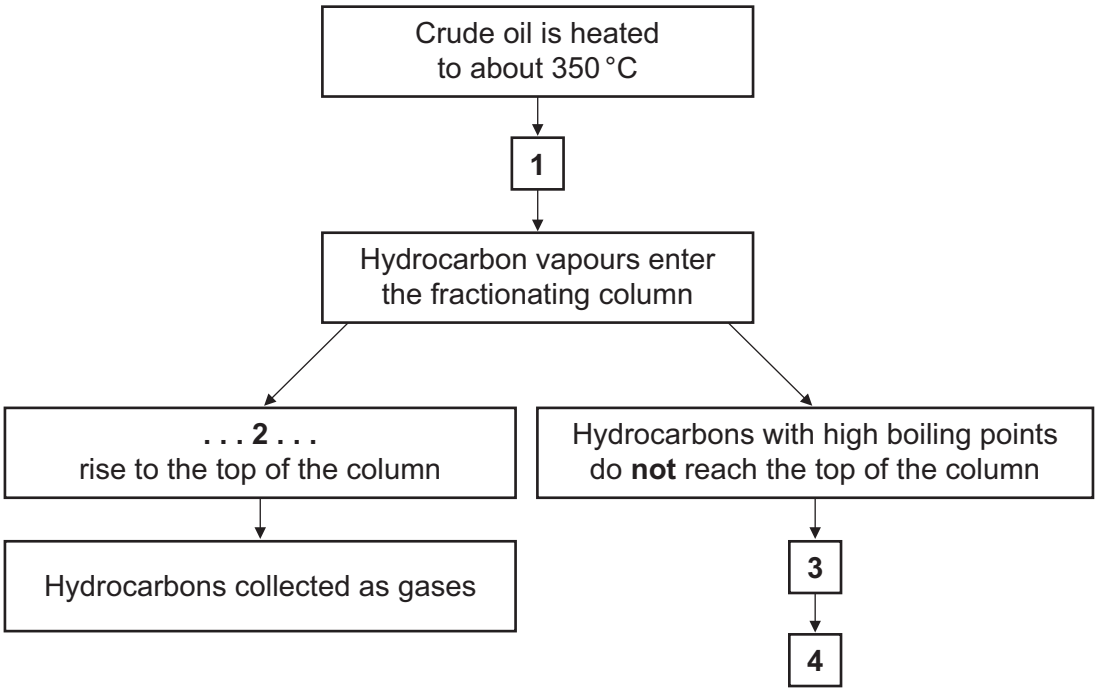
B Methane and hot air

C Limestone

D Quicklime

QUESTION TWO

The flow chart shows stages in the fractional distillation of crude oil.



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

A Hydrocarbons turn to vapour

B Hydrocarbons cool

C Hydrocarbons with low boiling points

D Hydrocarbons condense to form liquids

Turn over for the next question

Section Two

Questions **THREE** to **NINE**.

Each of these questions has four parts.

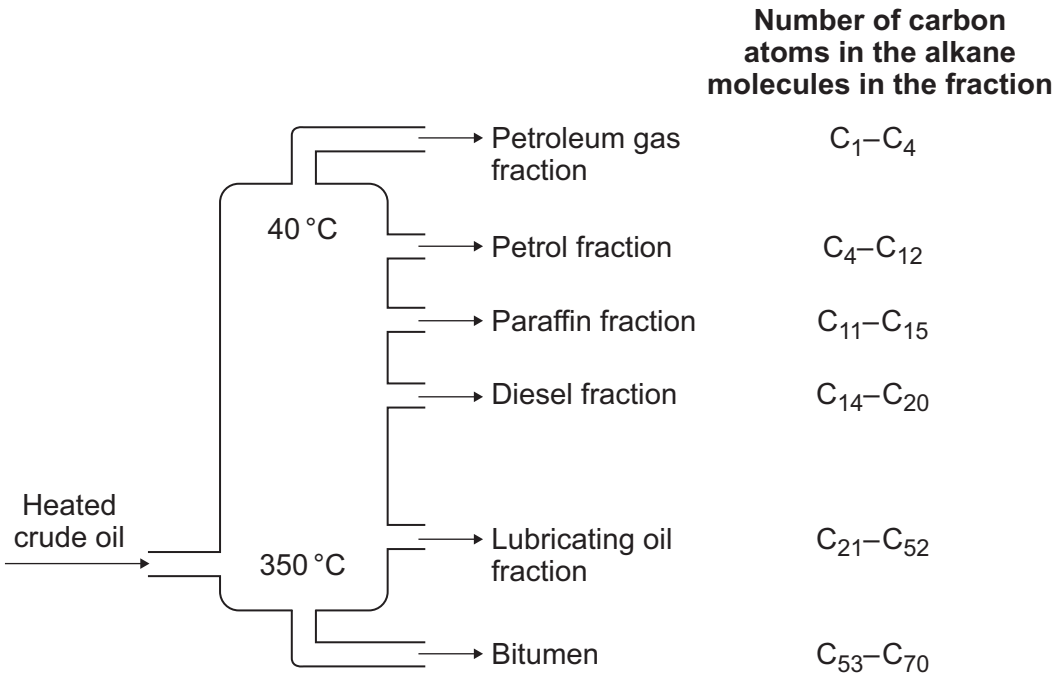
In each part choose only **one** answer.

Mark your choices on the answer sheet.

QUESTION THREE

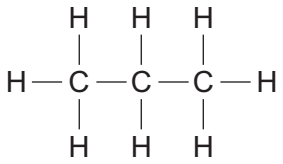
Crude oil can be separated into fractions.

Each fraction contains several alkanes.



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

1



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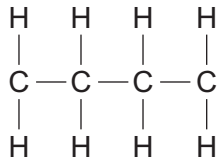

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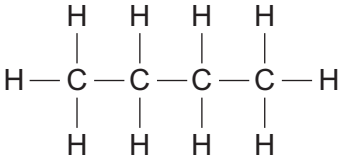
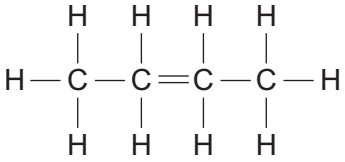


4



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

QUESTION FOUR

Iron oxide can be reduced to iron by mixing the oxide with carbon and heating strongly.

Aluminium oxide cannot be reduced to aluminium in this way. Aluminium is obtained from aluminium oxide by electrolysis.

4A Why is it possible to obtain iron but not aluminium by carbon reduction?

1 Iron is more reactive than aluminium.

2 Carbon is more reactive than aluminium but less reactive than iron.

3 Carbon is more reactive than iron but less reactive than aluminium.

4 Aluminium and iron are both more reactive than carbon.

4B The extraction of aluminium by electrolysis is an expensive process because . . .

1 aluminium easily corrodes in air.

2 a large amount of energy is needed.

3 aluminium oxide is difficult to mine.

4 aluminium reacts with carbon.

4C As electrolysis is expensive, an increasing amount of aluminium is being recycled.

Another important reason to recycle aluminium is that . . .

1 it saves limited aluminium oxide reserves.

2 the recycled aluminium is purer.

3 aluminium scrap does not corrode easily.

4 recycling aluminium does not use energy.

4D Which two of the following statements could explain why aluminium is preferred to iron for making cans for drinks?

W Aluminium has a lower density than iron.

X Aluminium is a better conductor than iron.

Y Aluminium corrodes less easily than iron.

Z Aluminium is not as strong as iron.

1 **W** and **X**

2 **W** and **Y**

3 **X** and **Y**

4 **Y** and **Z**

Turn over for the next question

QUESTION FIVE

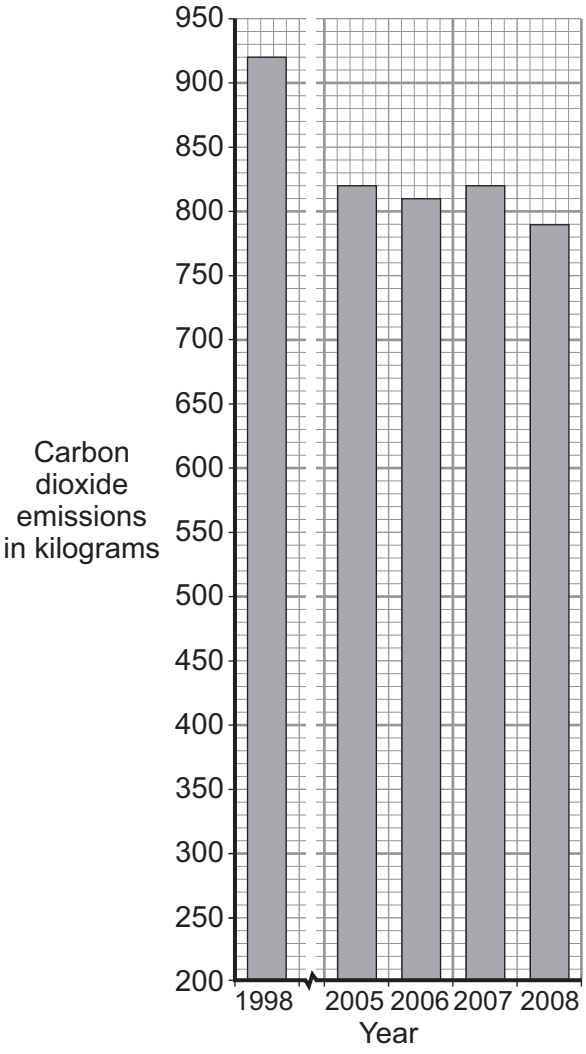
Cement is made in a rotary kiln, from a mixture of limestone and clay. The kiln is heated by burning a hydrocarbon fuel in air.

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.

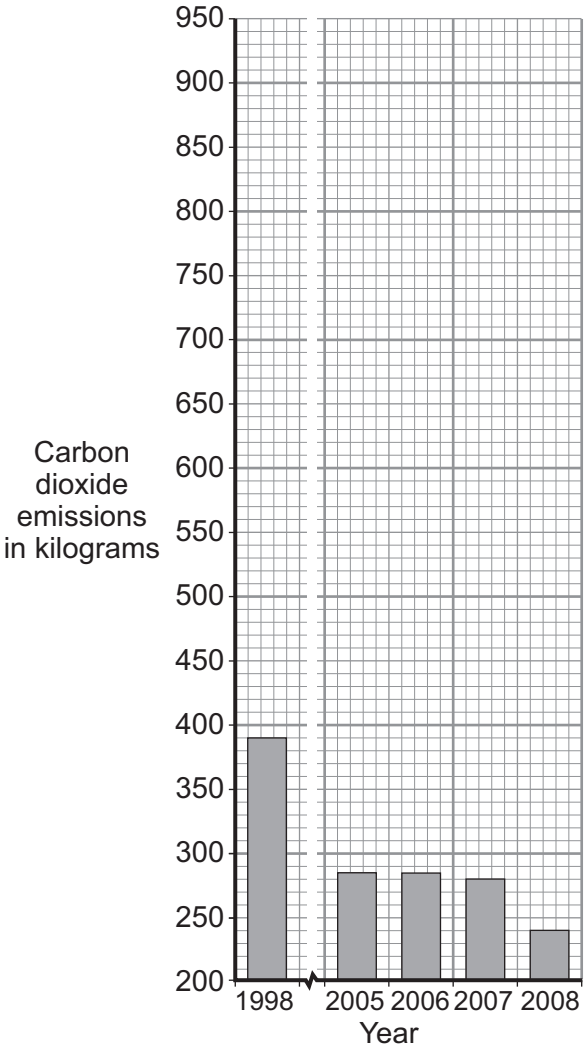
Graph 1

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



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.

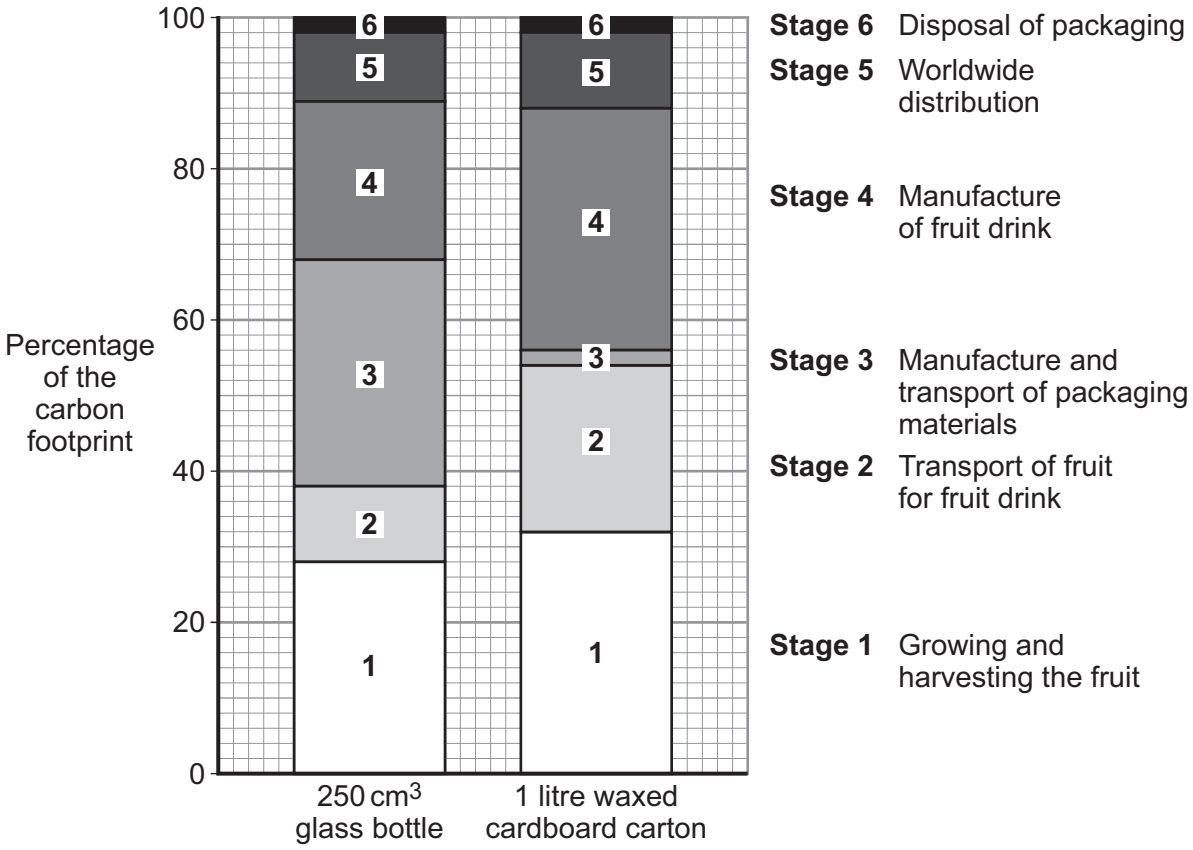
3 quicklime.

4 slaked lime.

QUESTION SIX

The carbon footprint of a food product is the total amount of carbon dioxide that is produced in its preparation, distribution and disposal.

The bar chart shows the percentage (%) of the carbon footprint for each stage of the overall process for a natural fruit drink. The fruit drink is packaged either in a 250 cm^3 glass bottle or in a 1 litre waxed cardboard carton.



6A Most of the carbon dioxide produced at **Stage 5** will be . . .

1 by electric trolleys at the supermarket storage depot.

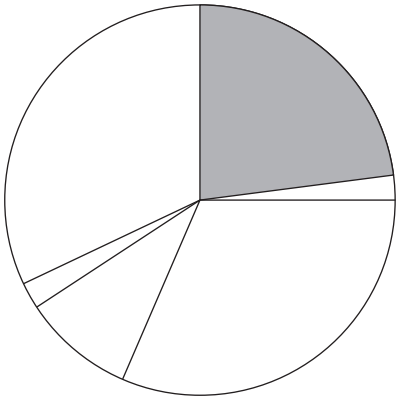
2 by lorries delivering bottles and cartons of the fruit drink.

3 by refrigerators at the supermarket storage depot.

4 by the large workforce at the distribution centre.

6B Which stage on the bar chart for a 1 litre carton corresponds to the shaded area on the pie chart?

Percentage (%) of carbon footprint for a 1 litre carton of natural fruit drink



1 **Stage 1**

2 **Stage 2**

3 **Stage 3**

4 **Stage 4**

6C One reason why, at **Stage 2**, the carbon footprint percentage is much smaller for a 250 cm^3 glass bottle than for a 1 litre carton is that . . .

1 a bottle contains a larger volume of liquid than a carton.

2 a bottle is heavier than a carton.

3 more fruit is needed to make the juice in a carton than in a bottle.

4 the fruit for the juice in the bottles is transported further than that for the juice in the cartons.

6D There is a large difference in the percentages at **Stage 3**.

One possible reason for this is that . . .

1 cartons are made of renewable materials.

2 making glass bottles needs a lot of energy.

3 cartons need more protective packaging than bottles.

4 glass bottles can be recycled but cartons cannot.

QUESTION SEVEN

Titanium (Ti) is extracted from the ore called rutile. Rutile is mainly made up of titanium oxide (TiO_2). Titanium is not very reactive so it should be possible to displace titanium from its oxide with carbon. But carbon reacts with titanium, making it very brittle.

Therefore, titanium is extracted by reacting titanium chloride ($TiCl_4$) with sodium. Titanium chloride is produced by reacting titanium oxide with chlorine. The sodium used for the reaction is obtained by electrolysis.

The titanium chloride is added to a reactor in which sodium has been heated to about 550 °C in an inert argon atmosphere. During the reaction, the temperature increases to about 1000 °C.
After the reaction is complete, and everything has cooled, which can take several days, the mixture is crushed and washed with water to remove the sodium chloride (NaCl).

7A Which row in the table is the correct order of reactivity for carbon, sodium and titanium?

	Most reactive ⟶		**Least reactive**
1	sodium	carbon	titanium
2	carbon	titanium	sodium
3	titanium	carbon	sodium
4	sodium	titanium	carbon

7B The equation for the reaction of titanium chloride with sodium is shown below.

$$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$$

When 190 g of titanium chloride were reacted with sodium, 48 g of titanium and 234 g of sodium chloride were produced.

How much sodium is required to produce 48 g of titanium?

1 23 g

2 92 g

3 190 g

4 234 g

7C A student suggested that there are four possible reasons why titanium is expensive.

J the cost of the process used to remove the sodium chloride
K large amounts of energy are needed to produce the sodium
L it takes several days to complete the process of separating the mixture
M the reacting mixture needs to be cooled to a low temperature

Which two of these reasons are correct?

1 **J** and **M**

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

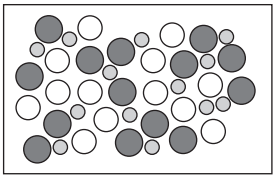
3 **J** and **K**

4 **L** and **M**

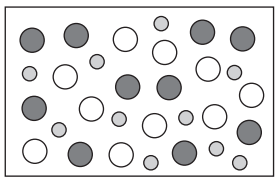
7D Titanium is often alloyed with small amounts of vanadium (4 %) and aluminium (6 %). This makes the titanium harder and stronger.

Which of the diagrams below shows the atoms in a sample of this titanium alloy?

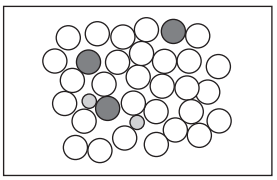
1



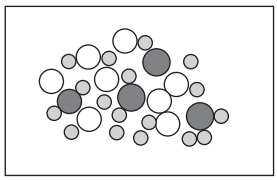
2

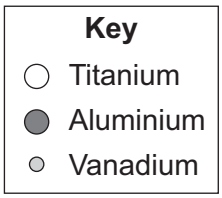


3



4





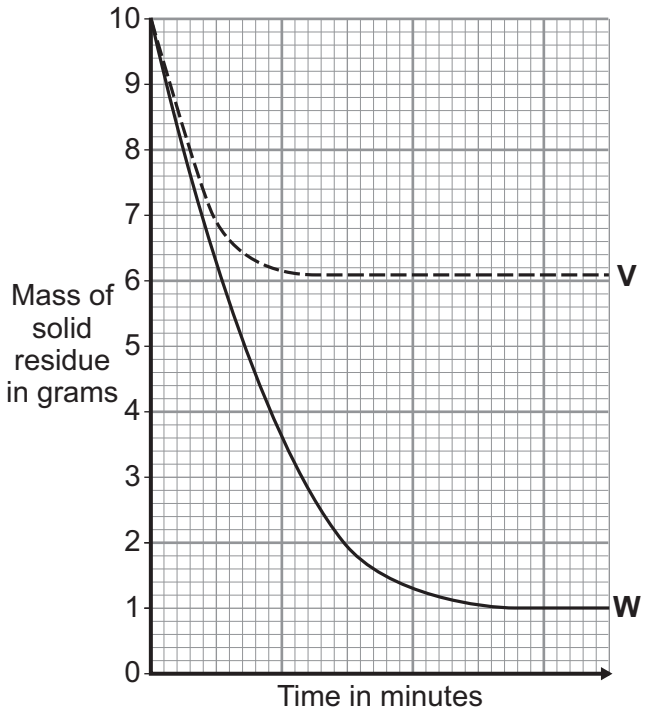
Turn over for the next question

QUESTION EIGHT

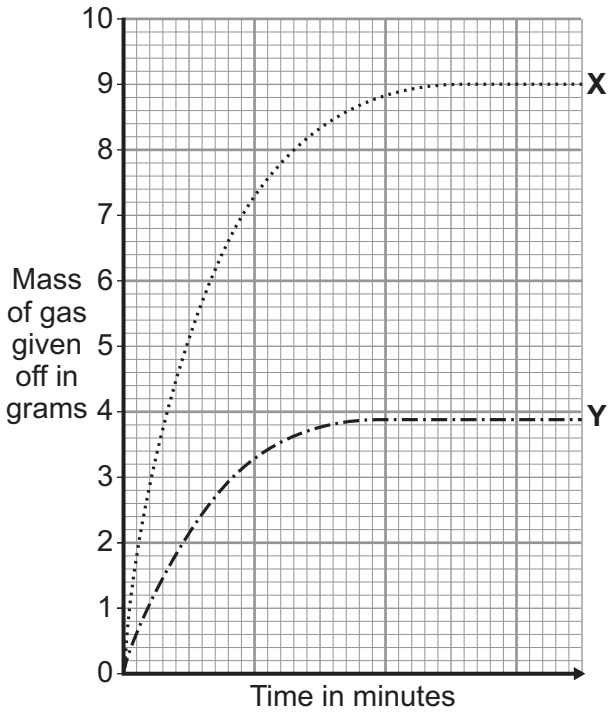
This question is about limestone and dolomite.

8A 10 g of limestone, which contained 10 % of an unreactive impurity, was heated strongly. The mass of the solid residue (**Graph 1**) and the mass of gas (**Graph 2**) given off were both recorded against time.

Graph 1



Graph 2



Which of the following lines on the graphs would be produced?

1 **V** and **X**

2 **V** and **Y**

3 **W** and **X**

4 **W** and **Y**

8B The formula for dolomite can be written as $CaMg(CO_3)_2$

What is the total number of atoms shown in this formula for dolomite?

1 4

2 7

3 10

4 12

8C Dolomite contains calcium carbonate and magnesium carbonate.

Magnesium carbonate decomposes when heated to temperatures above 540 °C.
Calcium carbonate decomposes when heated to temperatures above 900 °C.

Which row in the table correctly describes what happens when dolomite is heated to 750 °C?

	Calcium carbonate	Magnesium carbonate
1	No change	Undergoes reduction
2	Undergoes reduction	No change
3	No change	Undergoes thermal decomposition
4	Undergoes thermal decomposition	No change

8D Which of the following correctly completes and balances the equation for the total decomposition of dolomite?

$CaMg(CO_3)_2 \rightarrow$

1 $CaO + 2MgO + CO_2$

2 $CaO + Mg + 2CO_2$

3 $CaO + MgO + 2CO_2$

4 $Ca + Mg + 3CO_2$

Turn over for the next question

QUESTION NINE

Petrol and diesel are the fuels used for most cars.

Several companies are researching the use of hydrogen as a fuel for cars, instead of petrol or diesel.

Hydrogen can be used to power fuel cells. In a fuel cell, hydrogen is chemically combined with oxygen to generate electricity to run the car.

Hydrogen can be produced from natural gas or from water.

9A There are several reasons why this research is being carried out.

Which of the following is **not** one of the reasons?

1 There could be a shortage of petrol and diesel in the future.

2 There is political pressure to increase the number of cars on the road.

3 Petrol and diesel are obtained from a non-renewable source.

4 There is political pressure to reduce carbon emissions.

9B One reason why there are only a few hydrogen-powered cars on the road is that . . .

1 the raw materials to make hydrogen are scarce.

2 only water is produced when hydrogen burns.

3 fuel cell technology has been difficult to develop.

4 hydrogen-powered cars are made by only a few companies.

9C The development of hydrogen as a fuel for cars could be delayed even further if . . .

1 new, large deposits of crude oil are discovered.

2 a safe way of storing hydrogen is found.

3 hydrogen can be made more cheaply.

4 global warming continues to be a concern.

9D The very rare and expensive metal called palladium is capable of storing many hundreds of times its own volume of hydrogen.

Which statement would be true if palladium was used in hydrogen-powered cars?

1 The increased demand for palladium would cause its price to fall.

2 Hydrogen that had been stored in palladium would have a lower density.

3 Hydrogen that had been stored in palladium would be hard to burn.

4 The cars would be safer than those that store hydrogen in pressurised cylinders.

END OF TEST

There are no questions printed on this page

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