1 For 200 million years the proportions of the different gases in the atmosphere have been much the same as today. Over the past 150 years the amount of carbon dioxide in the atmosphere has increased from 0.03% to 0.04%.

(a) Describe how carbon dioxide is released into the atmosphere:

(i) by human and industrial activity;

.....

.....

.....

.....

(2)

(ii) from carbonate rocks by geological activity.

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(2)

(b) Explain how the seas and oceans can decrease the amount of carbon dioxide in the atmosphere.

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(3)

(c) (i) Give **one** reason why the amount of carbon dioxide in the atmosphere is increasing gradually.

.....

.....

(1)

(ii) Give **one** effect that increasing levels of carbon dioxide in the atmosphere may have on the environment.

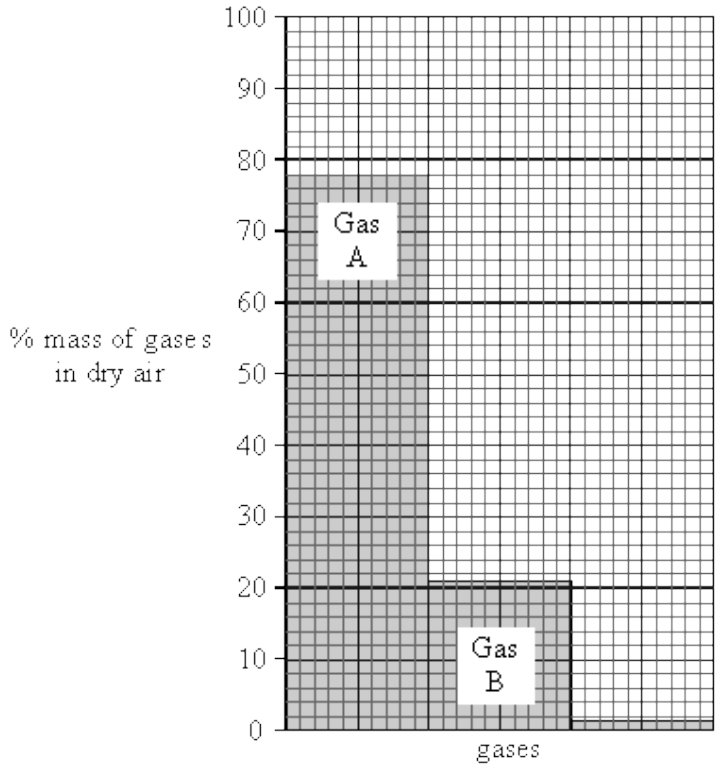
.....

.....

(1)

(Total 9 marks)

2 The bar chart below shows the percentage by mass of gases in dry air. Two of the gases are labelled as A and B.



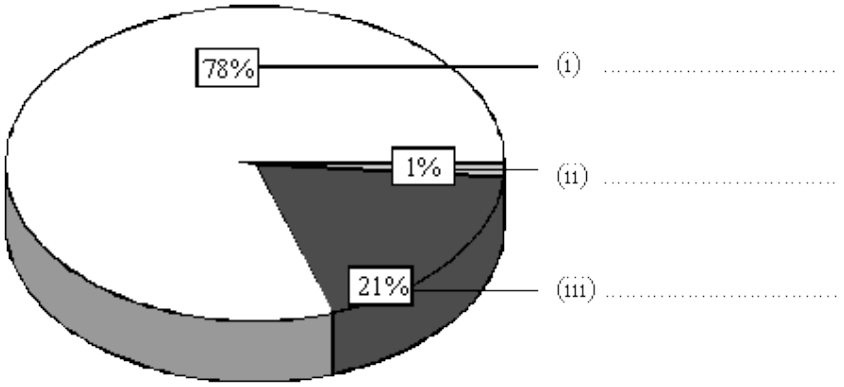
What are the names of gas A and gas B?

Gas A is .....

Gas B is .....

(Total 2 marks)

3 (a) Air is a mixture of gases. The pie chart shows the percentages, by volume, of the main gases in dry air. Complete the chart by adding the names of these **three** gases.



(3)

(b) Complete each of the **four** spaces in the sentences by choosing the best word from the box.

condenses	**condensing**	**evaporates**	**evaporating**
melts	**sea**	**trees**	**vapour**

The air in the atmosphere above this country always contains ..... .

Most of this is the result of water ..... from the surface of the

..... . Some of it ..... to form millions of tiny

drops of water in clouds.

(4)

(c) Thousands of millions of years ago the Earth's early atmosphere was formed. Complete the following sentence.

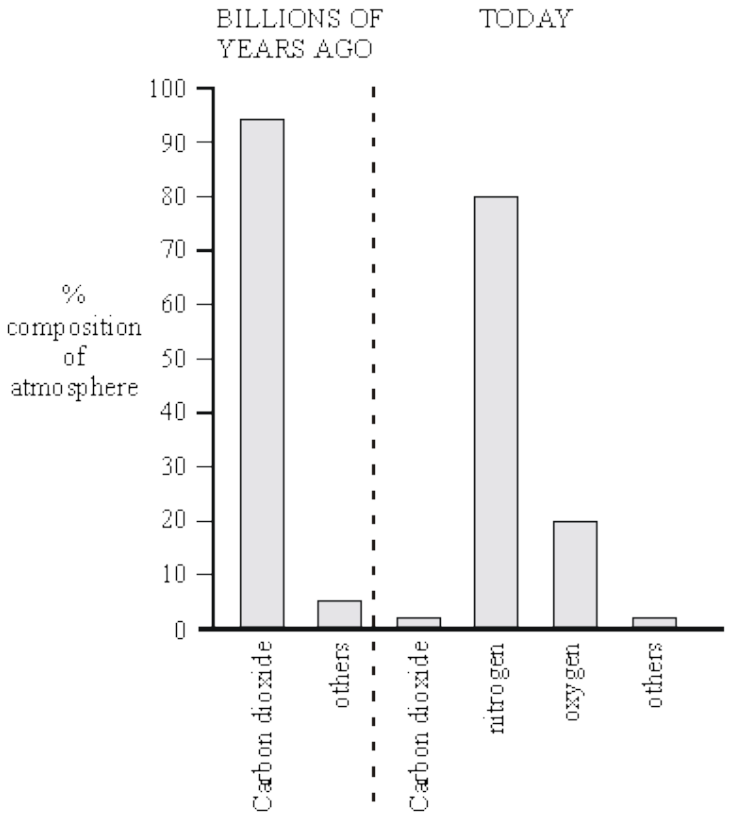
The carbon dioxide in this early atmosphere probably came from .....

..... .

(1)

(Total 8 marks)

4 The bar chart shows the composition of the Earth's atmosphere today, and as it was billions of years ago.



(a) Use information from the bar chart to describe how the atmosphere today is different from the atmosphere of billions of years ago.

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(2)

(b) Describe the processes which have brought about the changes in the proportions of these gases in the air over billions of years.

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(4)

(Total 6 marks)

5 There are many ideas about the formation of the Earth and its atmosphere from a molten ball of rock and minerals.

(a) One idea is that the Earth's early atmosphere and average surface temperature were probably like that of Venus today.

The table shows information about the Earth and Venus today.

	Percentage composition of atmosphere	
Name of gas	**Earth today**	**Venus today**
Nitrogen	78	3.5
Oxygen	21	a trace
Argon	0.97	a trace
Carbon dioxide	0.03	96.5
Average surface temperature	20 °C	460 °C

There is a variable amount of water vapour in both atmospheres.

(i) How was the Earth's early atmosphere formed?

.....

.....

(1)

(ii) The Earth's average surface temperature decreased over time. At what temperature would oceans have started to form?

Temperature = ... °C

(1)

(iii) Describe how the evolution of plants changed the Earth's atmosphere.

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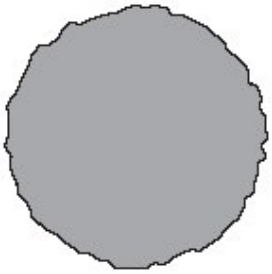
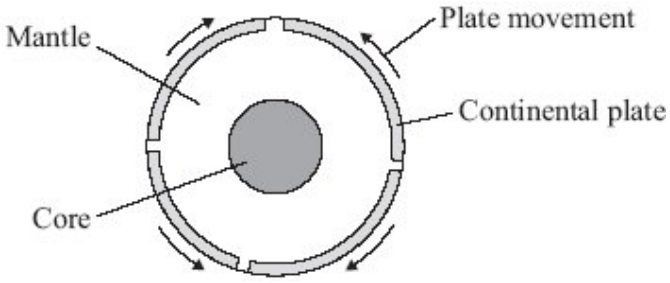
(2)

(b) Another idea was that the Earth's mountains and continents formed in fixed positions as the molten ball of rock and minerals cooled and wrinkled.



Wegener, in 1915, had the idea that the Earth's crust and the upper part of the mantle had cracked into plates that were able to move. His idea meant that the mountains and continents were not in fixed positions.



(i) Give **one** piece of evidence that led to Wegener's idea being accepted.

.....

.....

(1)

(ii) Describe what causes the Earth's tectonic plates to move.

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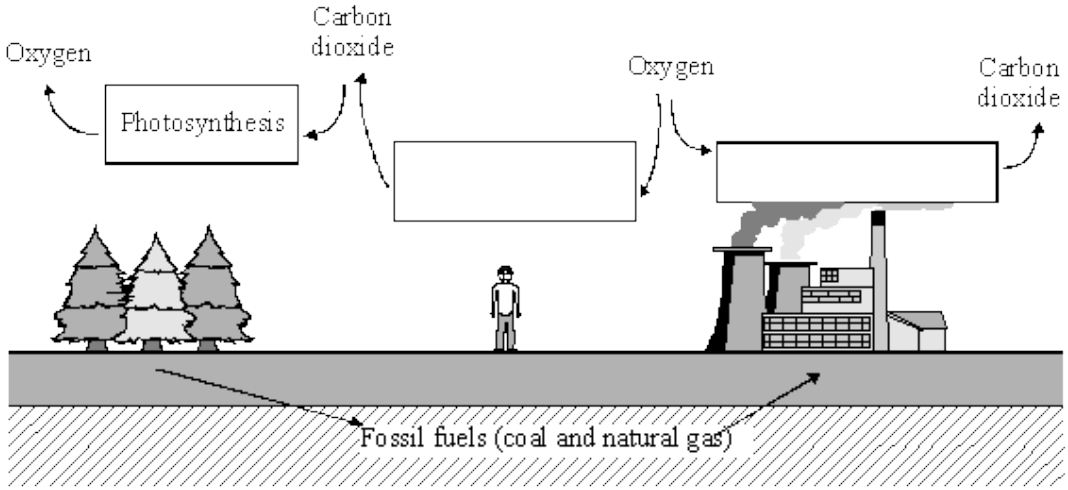
(3)

(Total 8 marks)

6 In the carbon cycle the amounts of carbon dioxide and oxygen in the air are changed by several processes.



(a) The names of some processes are given in the box below.

combustion	decomposition	neutralisation
photosynthesis		respiration

Choose the correct process for each box in the diagram. The first one has been done for you.

(2)

(b) Fossil fuels, such as natural gas, react with oxygen.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

..... + oxygen → carbon dioxide + ...

Complete the word equation for this reaction

(2)

(c) What problem is caused by the formation of large amounts of carbon dioxide?

.....

.....

(1)

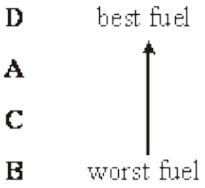
(Total 5 marks)

7 The table gives some data about four fuels, **A**, **B**, **C** and **D**.

Fuel	Cost in pence per 100 g	Energy in kJ per 100 g	Energy per penny in kJ	Gas (✓) formed on burning		
				Carbon dioxide	Sulphur dioxide	Water vapour
A	6.0	4 800	800	✓		✓
B	4.0	1 200	300	✓		✓
C	3.5	2 800	800	✓	✓	✓
D	18.0	14 400	800			✓

A student was asked to use the data in the table to compare these four fuels, and then place the fuels in an order.

The order that the student chose was:



Use the information in the table to suggest reasons why the student chose this order.

To gain full marks in this question you should write down your ideas in good English. Put them into a sensible order and use the correct scientific words.

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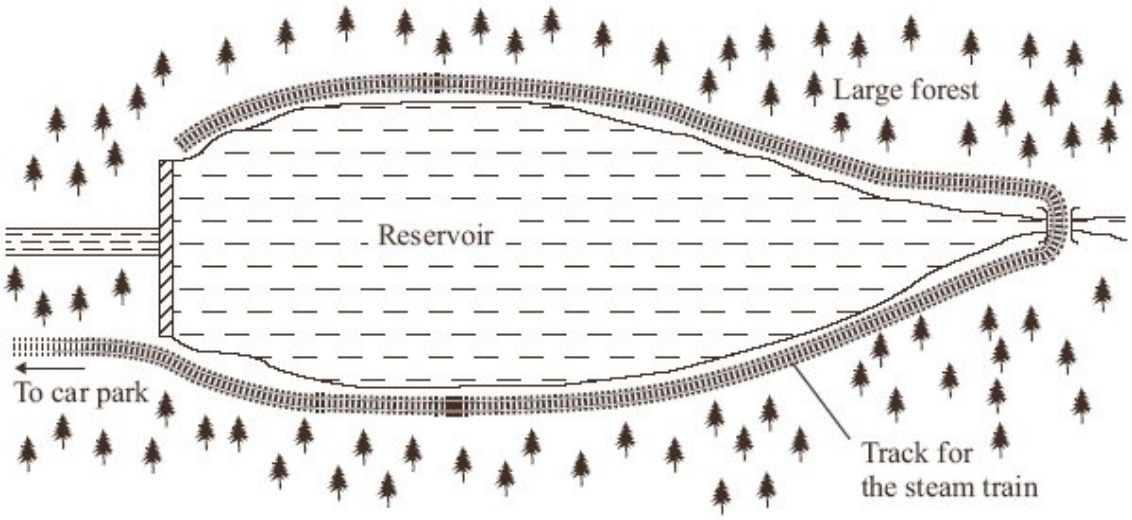
(Total 4 marks)

8 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.



(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.

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(4)

(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.

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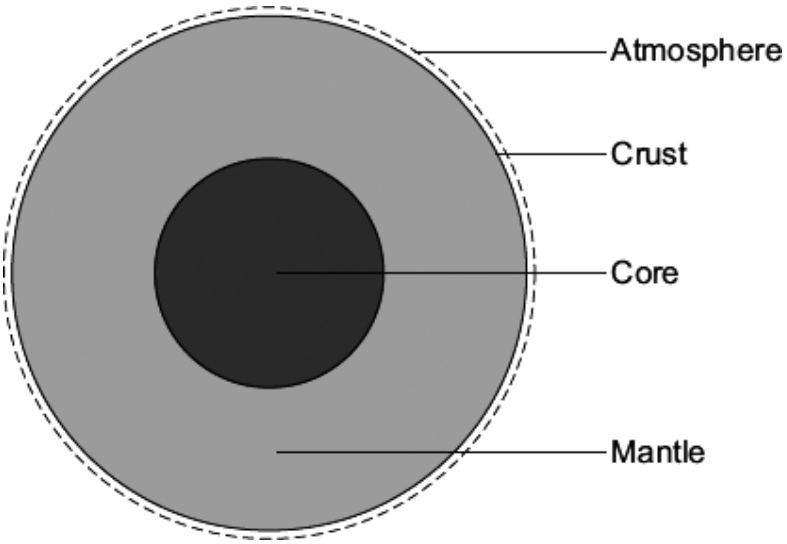
(3)

(Total 7 marks)

9 The Earth has a layered structure and is surrounded by an atmosphere.



(a) Scientists believe that the Earth's atmosphere was formed by volcanoes releasing gases. This early atmosphere was about 95 % carbon dioxide.
The composition of the Earth's atmosphere is always changing.

(i) The Earth's atmosphere today contains about 0.035 % carbon dioxide.

What happened to most of the carbon dioxide that was in the Earth's early atmosphere?

.....

.....

.....

.....

(2)

(ii) About 60 million years ago a large meteorite hit the Earth.
This meteorite heated limestone in the Earth's crust causing the release of large amounts of carbon dioxide.

Explain how carbon dioxide is released from limestone.

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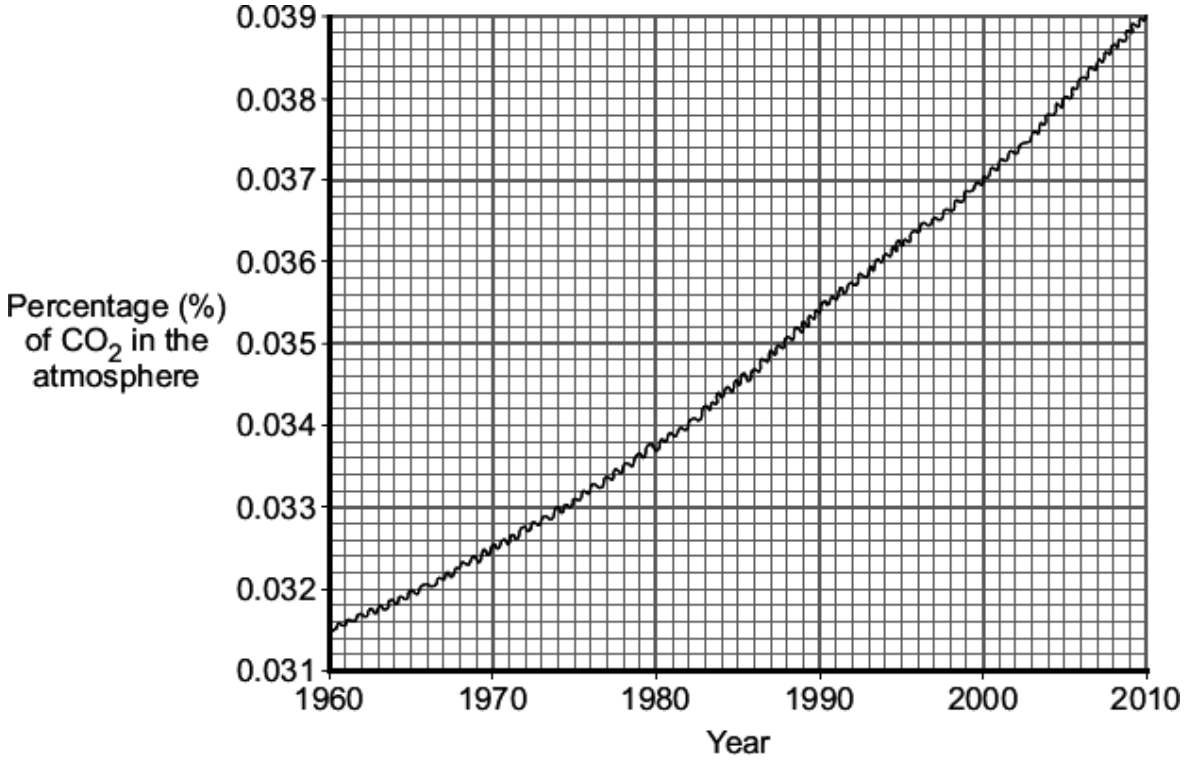
(2)

(b) The graph shows the percentage of carbon dioxide in the Earth's atmosphere over the last 50 years.



Explain, as fully as you can, why we should be concerned about the information displayed on this graph.

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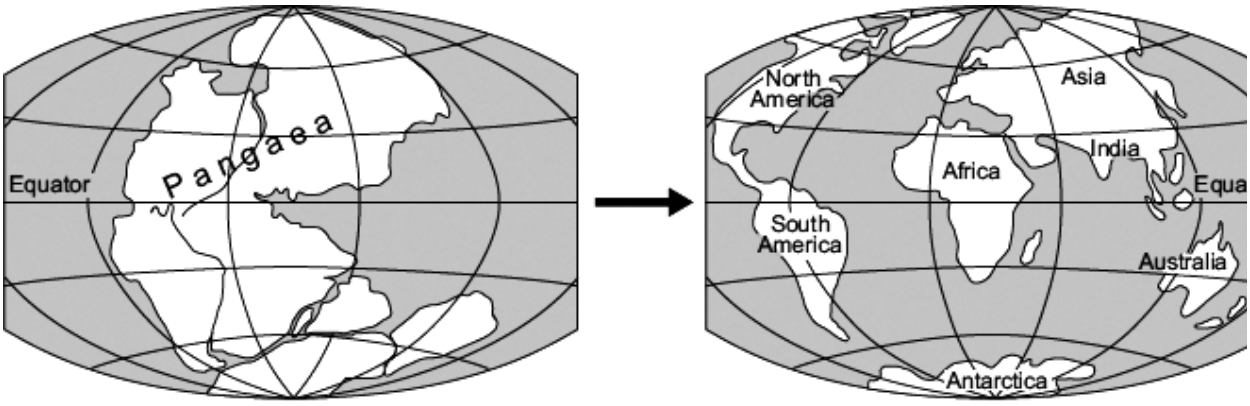
(3)

(c) Scientists believe that all the continents of the Earth were once joined together.
The huge 'supercontinent' was called Pangaea.



200 million years ago **Today**

In 1915, Alfred Wegener had an idea that the change shown in the diagram was caused by *continental drift.* Most scientists could not accept his idea.

(i) Suggest why most scientists in 1915 could not accept Wegener's idea of *continental drift.*

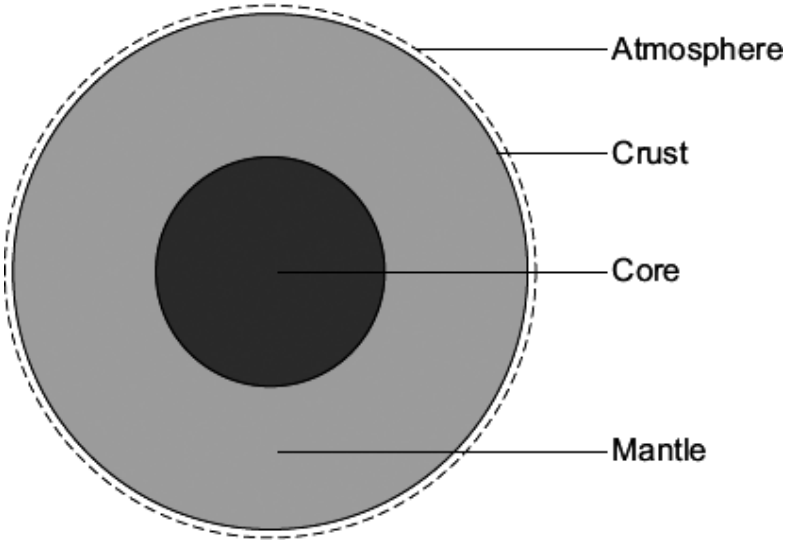
.....

.....

(1)

To help you with this question, the information and diagram from the beginning of the question are reproduced here.

The Earth has a layered structure and is surrounded by an atmosphere.



(ii) Use this information and your knowledge and understanding to explain how continents move.

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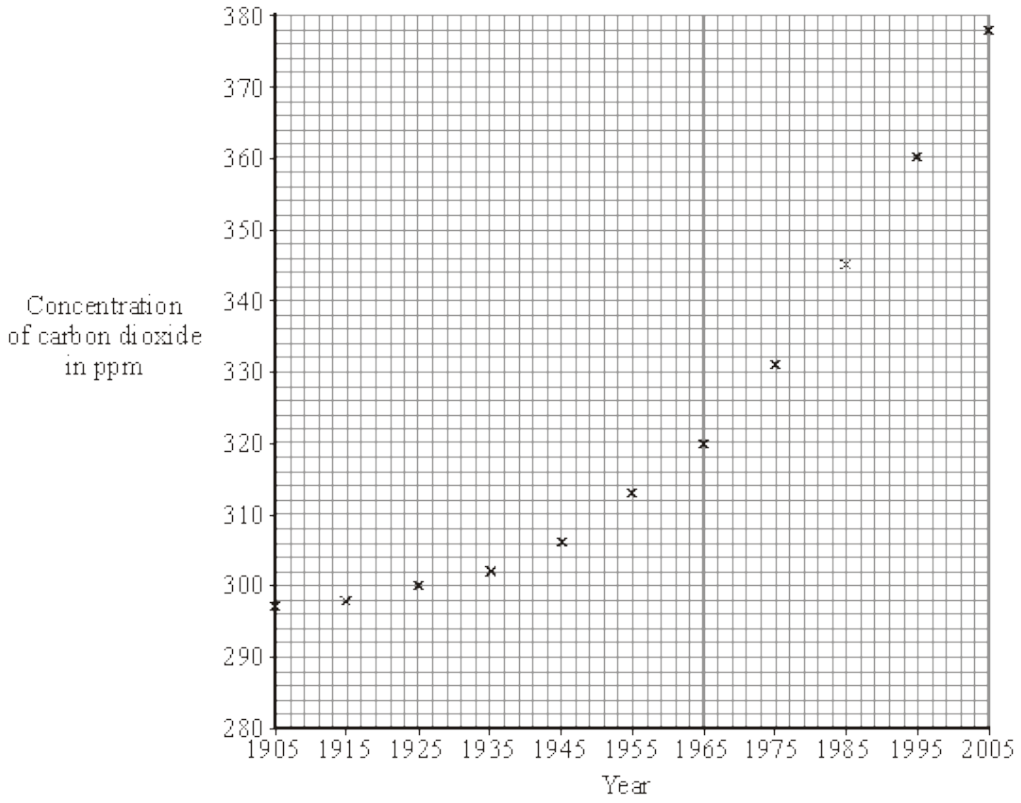
(3)

(Total 11 marks)

10 Global warming is thought to be happening because of the increased burning of fossil fuels. The concentration of carbon dioxide in the air from 1905 to 2005 has been calculated.



(a) Draw a line of best fit for these points.

(1)

(b) (i) What was the concentration of carbon dioxide in 1955?

..... ppm

(1)

(ii) In what year did the concentration of carbon dioxide reach 350 ppm?

.....

(1)

(c) Use the graph to describe, in as much detail as you can, what happened to the concentration of carbon dioxide from 1905 to 2005.

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(2)

(Total 5 marks)

11 Billions of years ago, the Earth's early atmosphere was probably like the atmosphere of Venus today.

The table shows a comparison of the atmospheres of the Earth and Venus today.

	Percentage composition of atmosphere	
Name of gas	**Earth today**	**Venus today**
Nitrogen	78	3.5
Oxygen	21	a trace
Argon	0.97	a trace
Carbon dioxide	0.03	96.5
Average surface temperature	20 ºC	460 ºC

(a) Use the names of gases from the table to complete the sentences.

(i) In the Earth's atmosphere today, the main gas is ..... .

(1)

(ii) In the Earth's atmosphere billions of years ago, the main gas was

..... .

(1)

(b) (i) Scientists do **not** know the accurate composition of the Earth's early atmosphere. Suggest why.

.....

.....

(1)

(ii) Use information from the table to answer this question.

Water vapour is present in the atmospheres of the Earth and Venus today.
The Earth's surface is mainly covered by water.

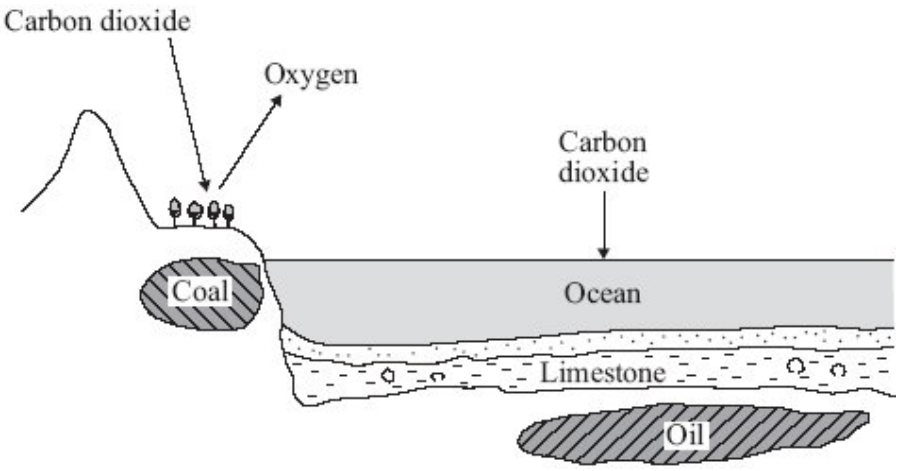
Suggest why there is no water on the surface of Venus.

.....

.....

(1)

(c) The diagram shows how carbon dioxide is removed from the Earth's atmosphere.



Describe what happened to the carbon dioxide in the Earth's early atmosphere. Use the diagram to help you.

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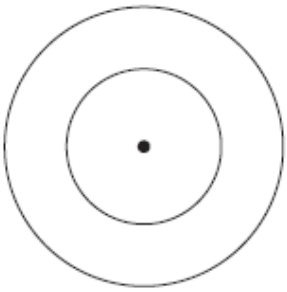
(3)

(Total 7 marks)

12 Fossil fuels contain carbon and hydrogen.

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

Complete the figure below to show the electronic structure of a carbon atom.



(1)

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

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?

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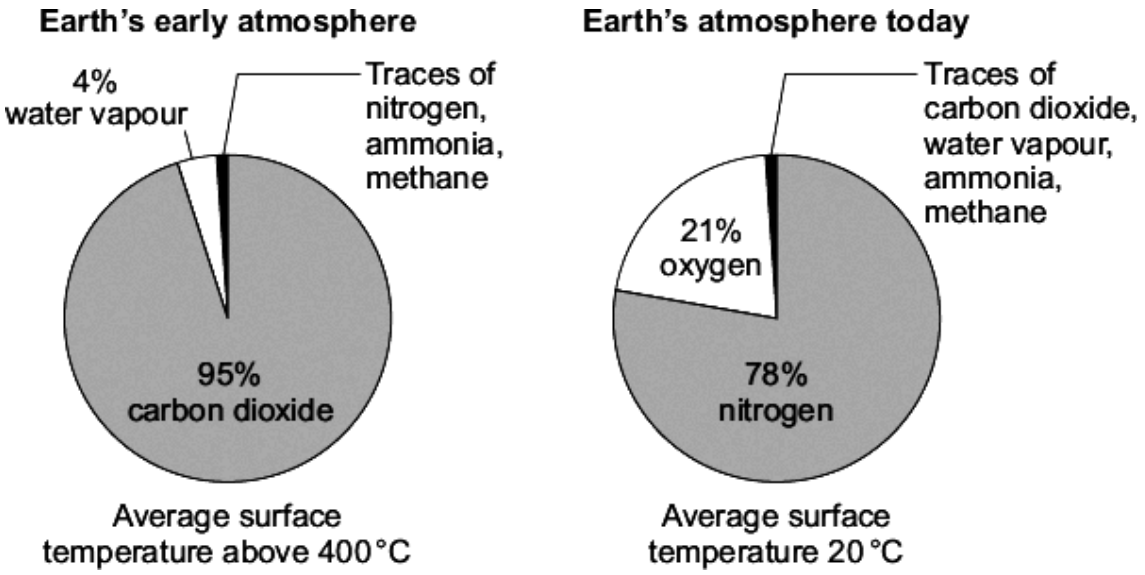
(4)

(Total 6 marks)

13 (a) Scientists have suggested that:

- the Earth formed as a molten ball of rock and minerals
- the rock and minerals cooled slowly
- the surface of the Earth was covered by volcanoes
- the volcanoes released gases that formed the Earth's early atmosphere.

The pie charts show the approximate percentages of gases in the Earth's early atmosphere and in the Earth's atmosphere today.



(i) Explain what has happened to most of the water vapour in the Earth's early atmosphere.

.....

.....

.....

.....

(2)

(ii) Give **two** reasons why the percentage of carbon dioxide in the Earth's early atmosphere decreased.

1 .....

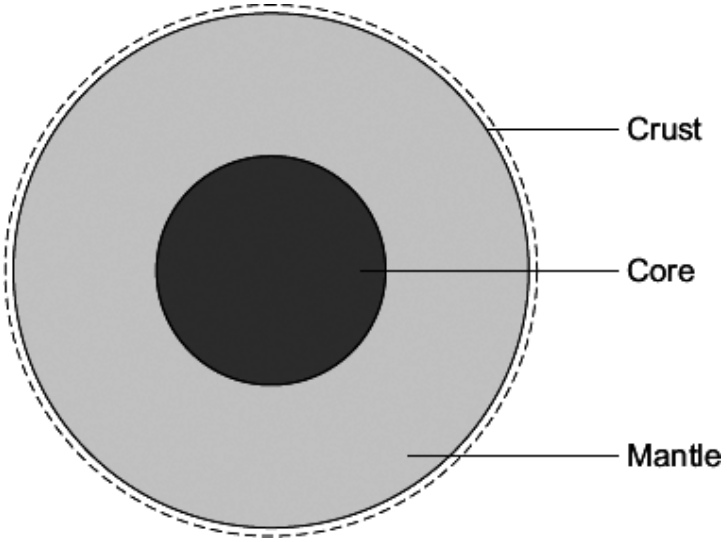
.....

2 .....

.....

(2)

(b) Scientists have suggested that the Earth consists of a core, mantle and crust.



A 'traditional' theory is that the core is made of iron and nickel.

A 'controversial' theory is that the core is like a nuclear reactor made of the radioactive elements uranium and plutonium.

(i) Why can scientists **not** prove which theory about the core is correct?

.....

.....

(1)

(ii) How can the 'controversial' theory be used to explain why the Earth's tectonic plates move?

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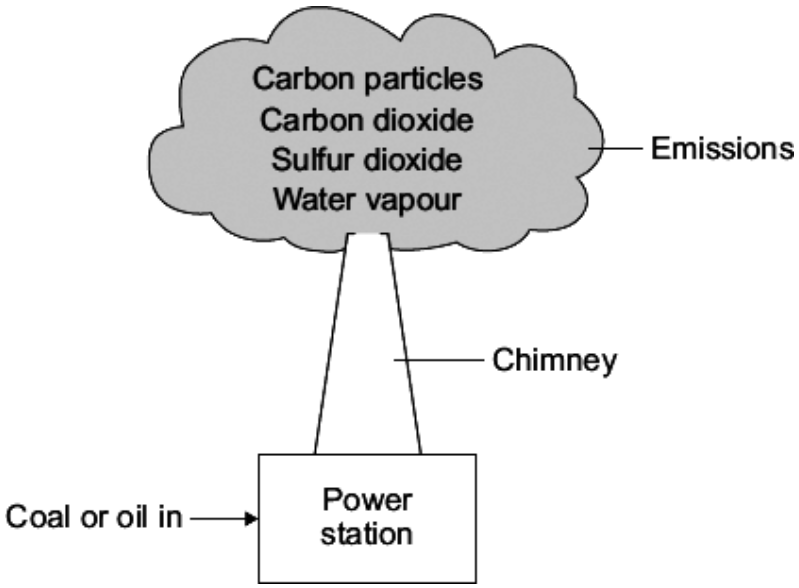
(3)

(Total 8 marks)

14 In the future more coal-fired and fewer oil-fired power stations will be used to generate electricity.
When coal and oil are burned they produce the same types of emissions which can cause environmental problems.



(a) Emissions from the chimney can cause acid rain, global dimming and global warming.
Draw **one** straight line from each possible environmental problem to the emission that causes it.

Possible environmental problem	**Emission that causes it**
	carbon particles
acid rain	
	carbon dioxide
global warming	
	sulfur dioxide
global dimming	
	water vapour

.....

(3)

(b) Draw a ring around the correct word in the box to complete each sentence.

(i) Incomplete combustion of coal or oil is caused by too little

carbon dioxide.
nitrogen.
oxygen.

(1)

(ii) A gas formed by the incomplete combustion of coal or oil is

carbon monoxide.
hydrogen.
oxygen.

(1)

(c) The table shows the world production for both coal and oil in 2000.

The world production figures after 2000 are predicted.

Year	World production of coal (billions of tonnes per year)	World production of oil (billions of barrels per year)
2000	3.5	12.5
2050	4.5	5.6
2100	5.0	1.7
2150	5.5	0.5
2200	6.0	0.0

(i) How is the world production of oil predicted to change from 2000 to 2200?

.....

.....

(1)

(ii) Suggest **two** reasons why the world production of coal is predicted to increase.

1 .....

.....

2 .....

.....

(2)

(Total 8 marks)

15 Many human activities result in carbon dioxide emissions.
Our carbon footprint is a measure of how much carbon dioxide we each cause to be produced.

(a) Why should we be concerned about our carbon footprint?

.....

.....

.....

(1)

(b) Most power stations in the UK burn coal.
Coal was formed from tree-like plants over millions of years.

Suggest why burning wood instead of coal would help to reduce our carbon footprint.

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(3)

(Total 4 marks)

16 Some theories suggest that the Earth's early atmosphere was the same as Mars' atmosphere today.

The table below shows the percentage of four gases in the atmosphere of Mars today and the atmosphere of Earth today.

Gases	**The atmosphere of**	
	Mars today	**Earth today**
Carbon dioxide	95.00%	0.04%
Nitrogen	3.50%	78.00%
Argon	1.00%	0.96%
Oxygen	0.50%	21.00%

(a) Which **one** of the gases in the table is a noble gas?

.....

(1)

(b) Draw a ring around the correct answer to complete each sentence.

(i) Noble gases are in Group

0

1

7

(1)

(ii) Noble gases are

slightly reactive.
unreactive.
very reactive.

(1)

(c) The percentage of carbon dioxide in the Earth's early atmosphere was 95.00%.
It is 0.04% in the Earth's atmosphere today.

(i) Calculate the decrease in the percentage of carbon dioxide in the Earth's atmosphere.

.....

.....

Decrease in percentage = ...%

(1)

(ii) Give **two** reasons for this decrease.

.....

.....

.....

.....

(2)

(Total 6 marks)

17 The amount of carbon dioxide in the Earth's atmosphere has changed since the Earth was formed.
The amount of carbon dioxide continues to change because of human activities.

(a) Cement is produced when a mixture of calcium carbonate and clay is heated in a rotary kiln. The fuel mixture is a hydrocarbon and air.

Hydrocarbons react with oxygen to produce carbon dioxide.
Calcium carbonate decomposes to produce carbon dioxide.

(i) Complete each chemical equation by writing the formula of the other product.

$$CH_4 + 2O_2 \longrightarrow 2 \text{.....} + CO_2$$

$$CaCO_3 \longrightarrow \text{.....} + CO_2$$

(2)

(ii) Hydrocarbons and calcium carbonate contain *locked up* carbon dioxide.

What is *locked up* carbon dioxide?

.....

.....

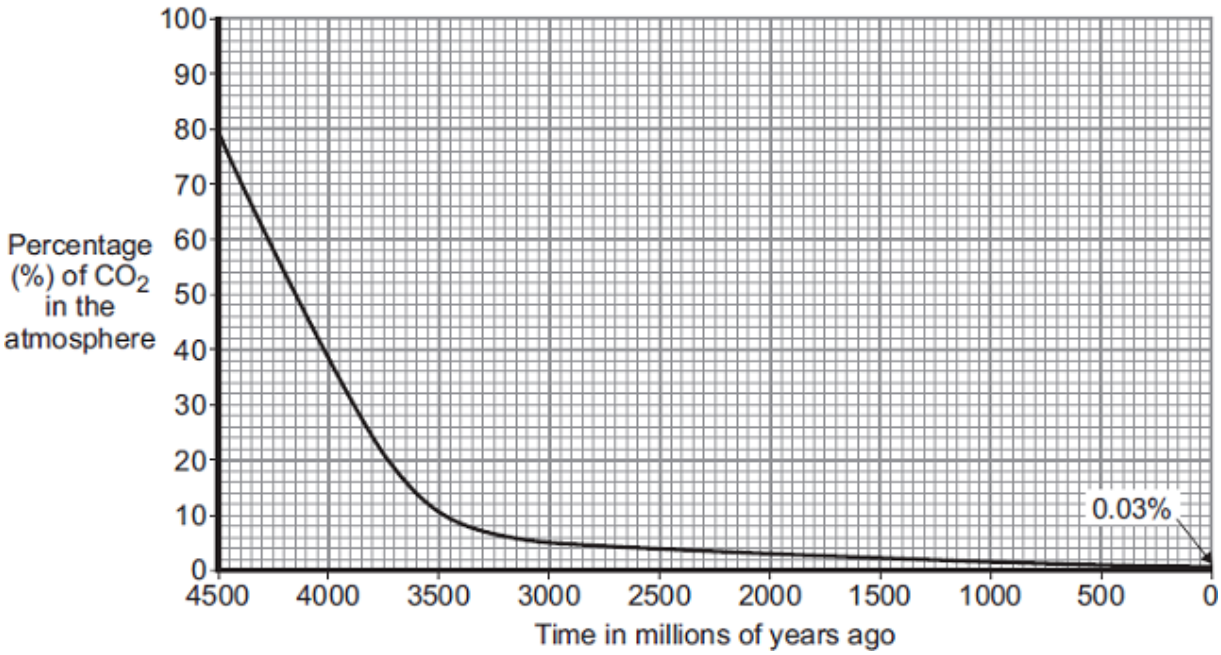
.....

.....

(2)

(b) **Graph 1** shows how the percentage of carbon dioxide in the atmosphere changed in the last 4500 million years.

Graph 1



Use information from **Graph 1** to answer these questions.

(i) Describe how the percentage of carbon dioxide has changed in the last 4500 million years.

.....

.....

.....

.....

(2)

(ii) Give **two** reasons why the percentage of carbon dioxide has changed.

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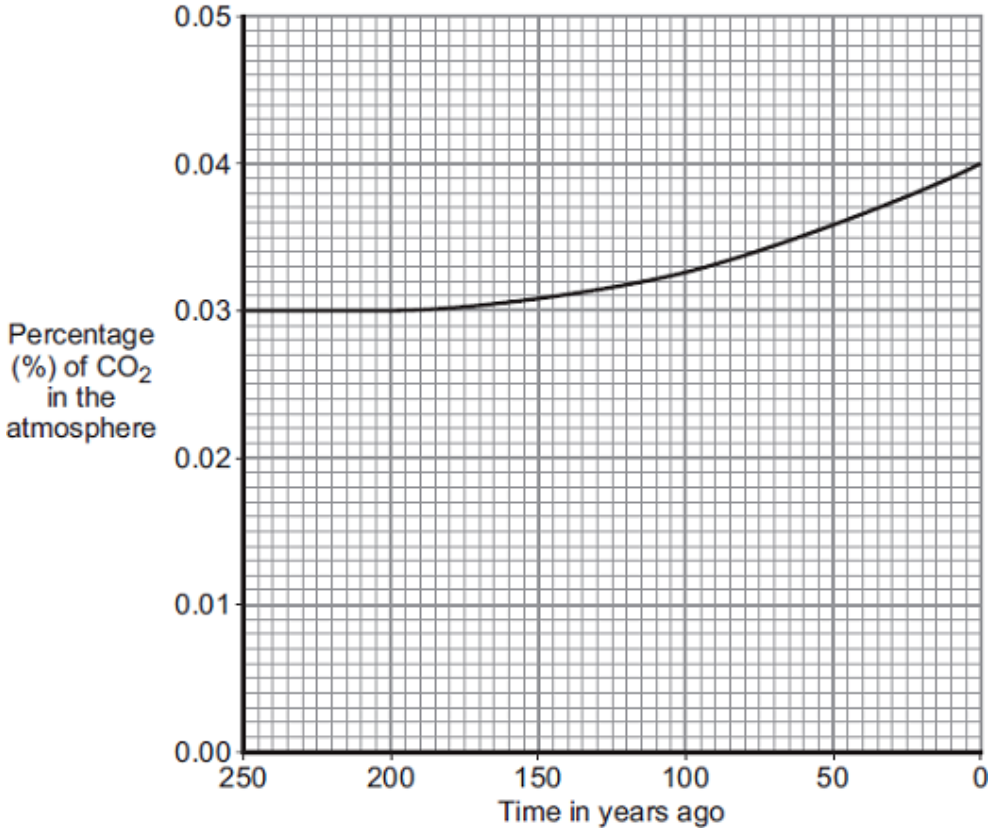
(2)

(c) **Graph 2** shows how the percentage of carbon dioxide in the atmosphere changed in the last 250 years.

Graph 2



Should we be concerned about this change in the percentage of carbon dioxide?

Explain your answer.

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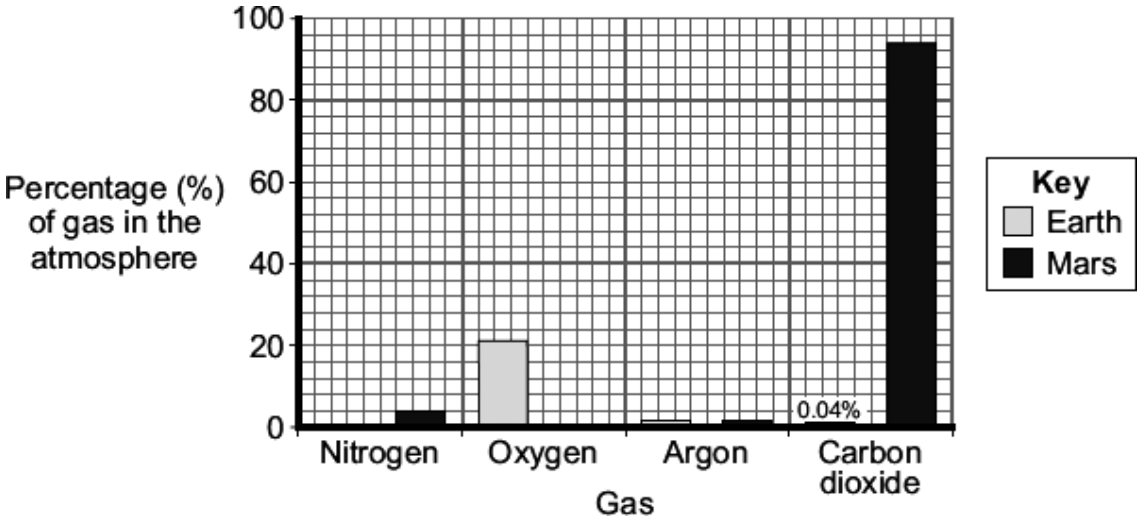
(2)

(Tota 10 marks)

18 The bar chart shows some of the gases in the atmospheres of Earth today and Mars today.



(a) Complete the bar chart to show the percentage of nitrogen in the Earth's atmosphere today.

(1)

(b) Some scientists suggest that the Earth's early atmosphere was like the atmosphere of Mars today.

(i) There is **not** much oxygen in the atmosphere of Mars.

Suggest why.

.....

.....

(1)

(ii) The percentage of argon in the Earth's atmosphere today is the same as it was in the Earth's early atmosphere.

Suggest why.

.....

.....

(1)

(c) Compared with the percentage of carbon dioxide in the Earth's early atmosphere there is **not** much carbon dioxide in the Earth's atmosphere today.

Give **one** reason for this change.

.....

.....

(1)

(d) Draw a ring around the correct answer to complete the sentence.

Some theories suggest that the Earth's early atmosphere was

made by

- burning fossil fuels.
- the formation of oceans.
- the eruption of volcanoes.

(1)

(Total 5 marks)

19 Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere has changed.

(a) Millions of years ago the Earth's atmosphere was probably just like that of Mars today.

The table shows data about the atmosphere of Mars and Earth today.

Mars today		**Earth today**	
nitrogen	3%	nitrogen	78%
oxygen	trace	oxygen	21%
water	trace	water	trace
Carbon dioxide	95%	Carbon dioxide	trace
Average surface temperature −23°C		Average surface temperature 15°C	

The percentages of some gases in the Earth's atmosphere of millions of years ago have changed to the percentages in the Earth's atmosphere today.

For **two** of these gases describe how the percentages have changed **and** suggest what caused this change.

.....

.....

.....

.....

(2)

(b) Titan is the largest moon of the planet Saturn.
Titan has an atmosphere that contains mainly nitrogen.
Methane is the other main gas.

Main gases in Titan's atmosphere	Percentage (%)	Boiling point in °C
Nitrogen	95	−196
Methane	5	−164
Average surface temperature −178°C		

When it rains on Titan, it rains methane!

Use the information above and your knowledge and understanding to explain why.

.....

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(2)

(c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene (C_2H_4) and propene (C_3H_6) from methane in Titan's atmosphere.

State the general formula for alkenes.

.....

(1)

(Total 5 marks)

20 Greenhouse gases affect the temperature of the Earth.

(a) Which gas is a greenhouse gas?

Tick **one** box.

Argon ☐

Methane ☐

Nitrogen ☐

Oxygen ☐

(1)

(b) An increase in global temperature will cause climate change.

What is **one** possible effect of climate change?

Tick **one** box.

Deforestation ☐

Global dimming ☐

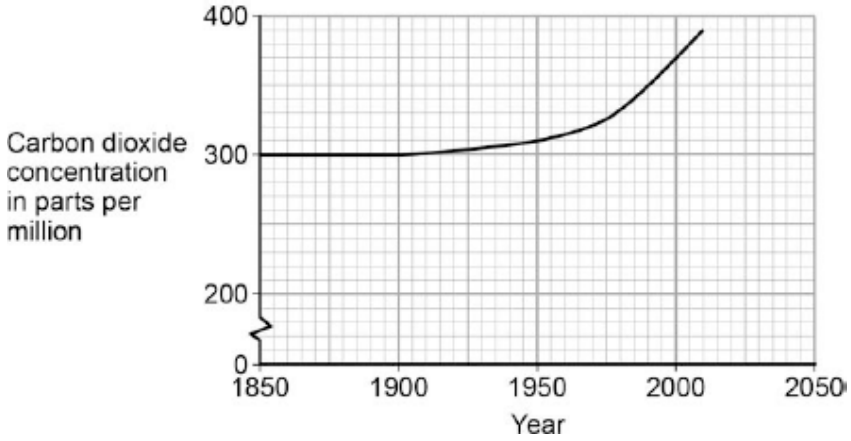
Sea levels rising ☐

Volcanic activity ☐

(1)

(c) Carbon dioxide is also a greenhouse gas.

The figure below shows how the concentration of carbon dioxide in the atmosphere has changed since 1850.



Which process is the reason for the change in carbon dioxide concentration shown on the figure above?

Tick **one** box.

Burning of fossil fuels ☐

Carbon capture ☐

Formation of sedimentary rocks ☐

Photosynthesis ☐

(1)

(d) Give **three** conclusions that can be made from the figure above.

1 .....

.....

2 .....

.....

3 .....

.....

(3)

(Total 6 marks)

21 This question is about life, the Earth and its atmosphere.

(a) There are many theories about how life was formed on Earth.

Suggest **one** reason why there are many theories.

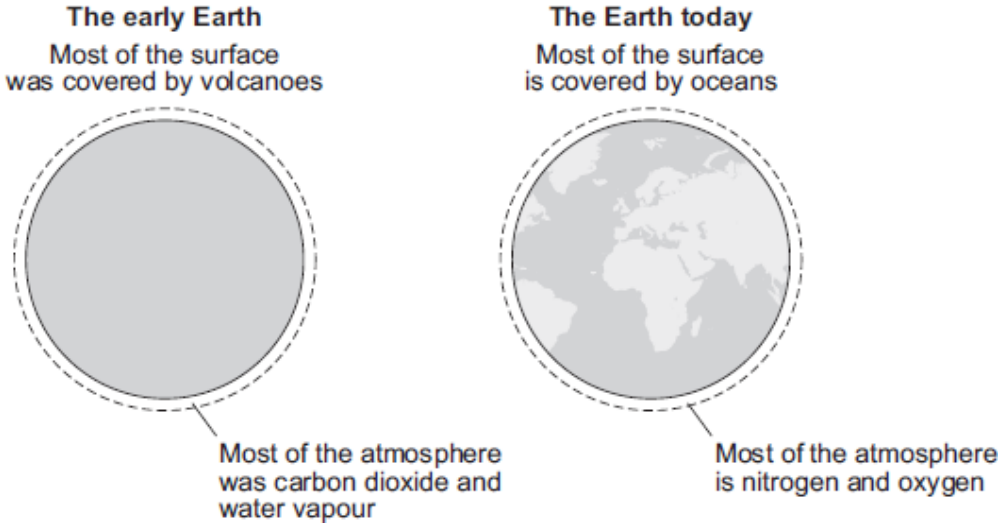
.....

.....

(1)

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

This Earth and its atmosphere today are not like the early Earth and its atmosphere.



Describe and explain how the surface of the early Earth and its atmosphere have changed to form the surface of the Earth and its atmosphere today.

.....

.....

.....

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.....

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.....

.....

(6)

(Total 7 marks)

22 This question is about the temperature of the Earth's atmosphere.

(a) Give **one** reason why it is difficult to produce models for future climate change.

.....

.....

(1)

(b) Describe how carbon dioxide helps to maintain temperatures on Earth.

.....

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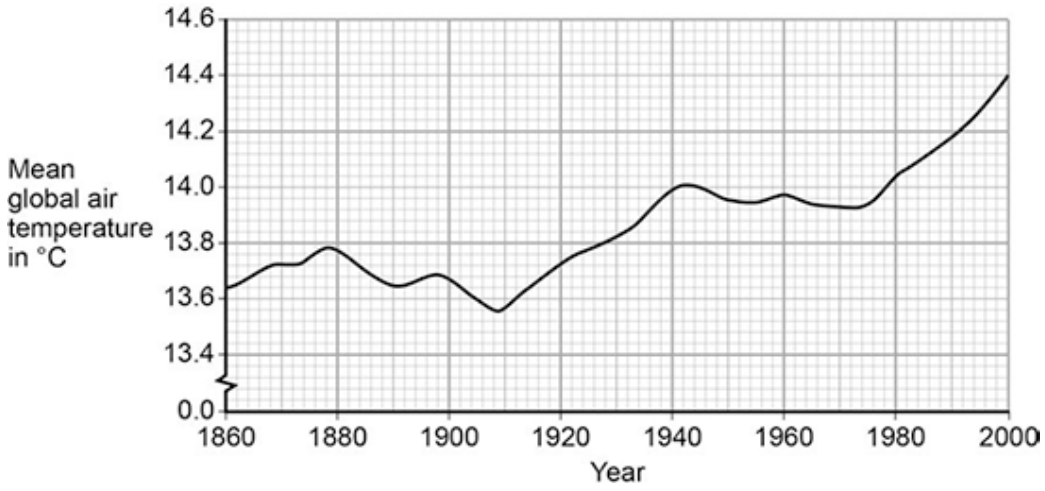
.....

(3)

(c) The figure below shows the change in mean global air temperature from 1860 to 2000.



Explain how human activities have contributed to the main trend shown from 1910 in the figure above.

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(3)

(Total 7 marks)

23 Sulfur is a non-metal.

Sulfur burns in the air to produce sulfur dioxide, SO_2

(a) Why is it important that sulfur dioxide is **not** released into the atmosphere?

Tick (✓) **one** box.

Sulfur dioxide causes acid rain. ☐

Sulfur dioxide causes global dimming. ☐

Sulfur dioxide causes global warming. ☐

(1)

(b) Sulfur dioxide dissolves in water.

What colour is universal indicator in a solution of sulfur dioxide?
Give a reason for your answer.

.....

.....

.....

.....

(2)

(c) Sulfur dioxide is a gas at room temperature.

The bonding in sulfur dioxide is covalent.

Explain, in terms of its structure and bonding, why sulfur dioxide has a low boiling point.

.....

.....

.....

.....

.....

.....

(3)

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

Sulfur dioxide is produced when fossil fuels are burned.

It is important that sulfur dioxide is not released into the atmosphere.

Three of the methods used to remove sulfur dioxide from gases produced when fossil fuels are burned are:

- wet gas desulfurisation (**W**)
- dry gas desulfurisation (**D**)
- seawater gas desulfurisation (**S**).

Information about the three methods is given in the bar chart and in **Table 1** and **Table 2**.

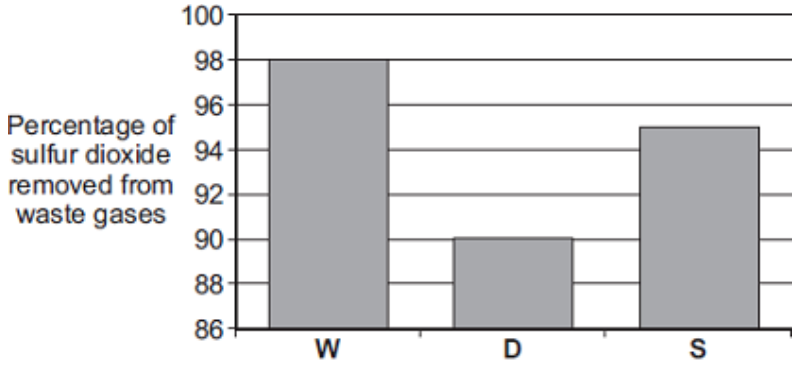

Table 1

Method	Material used	How material is obtained
W	Calcium carbonate, $CaCO_3$	Quarrying
D	Calcium oxide, CaO	Thermal decomposition of calcium carbonate: $CaCO_3 \longrightarrow CaO + CO_2$
S	Seawater	From the sea

Table 2

Method	What is done with waste material
W	Solid waste is sold for use in buildings. Carbon dioxide is released into the atmosphere.
D	Solid waste is sent to landfill.
S	Liquid waste is returned to the sea.

Evaluate the three methods of removing sulfur dioxide from waste gases.

Compare the three methods and give a justified conclusion.

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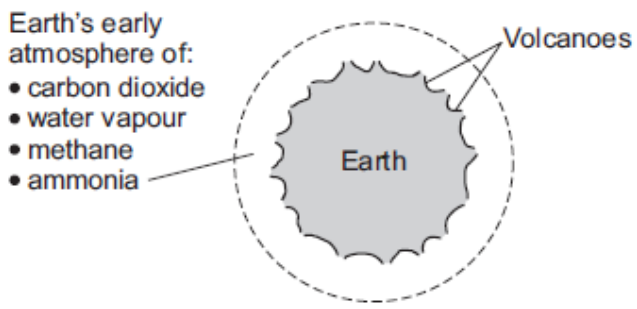
(6)

(Total 12 marks)

24 This question is about the Earth and its atmosphere.

(a) **Figure 1** shows the Earth and its atmosphere billions of years ago.

Figure 1



The boiling point of water is 100 °C.

Suggest **one** reason why there was no liquid water on the Earth's surface billions of years ago.

.....

.....

(1)

(b) The Earth's atmosphere today contains nitrogen, oxygen, argon, carbon dioxide and other gases.

(i) Draw **one** line from each substance to a description of the substance.

Substance	Description of the substance
air	compound
carbon dioxide	element
argon	hydrocarbon
	metal
	mixture

(3)

(ii) Which gas in the Earth's atmosphere is used when hydrocarbons burn?

Tick (✓) **one** box.

carbon dioxide ☐

nitrogen ☐

oxygen ☐

(1)

(iii) What percentage of the Earth's atmosphere is nitrogen?

Tick (✓) **one** box.

about 40% ☐

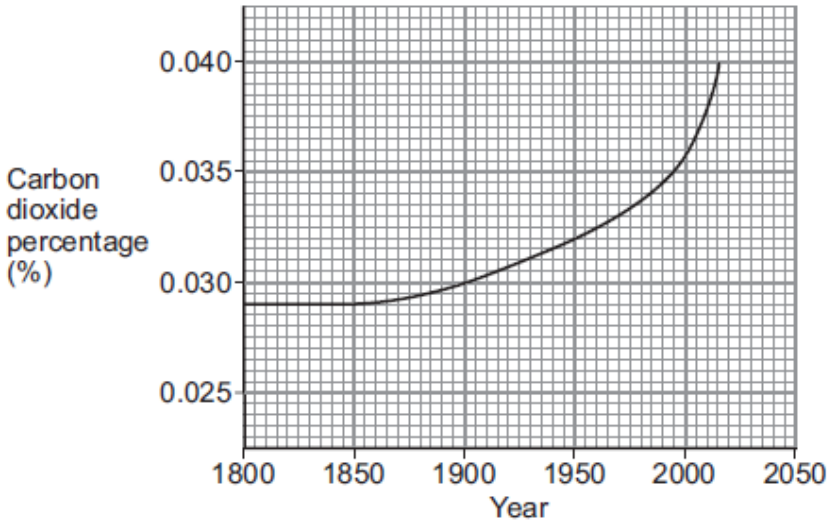
about 60% ☐

about 80% ☐

(1)

(c) **Figure 2** shows the carbon dioxide percentage (%) in the Earth's atmosphere since the year 1800.

Figure 2



(i) What was the carbon dioxide percentage in 1900?

..... %

(1)

(ii) Describe, in detail, how the carbon dioxide percentage changed from 1900 to 2015.

.....

.....

.....

.....

(2)

(iii) Suggest **two** reasons for the change in the carbon dioxide percentage from 1900 to 2015.

1 .....

.....

2 .....

.....

(2)

(Total 11 marks)

25 This question is about copper.

(a) Copper can be extracted by smelting copper-rich ores in a furnace.

The equation for one of the reactions in the smelting process is:

$$Cu_2S(s) + O_2(g) \longrightarrow 2\,Cu(s) + SO_2(g)$$

Explain why there would be an environmental problem if sulfur dioxide gas escaped into the atmosphere.

.....

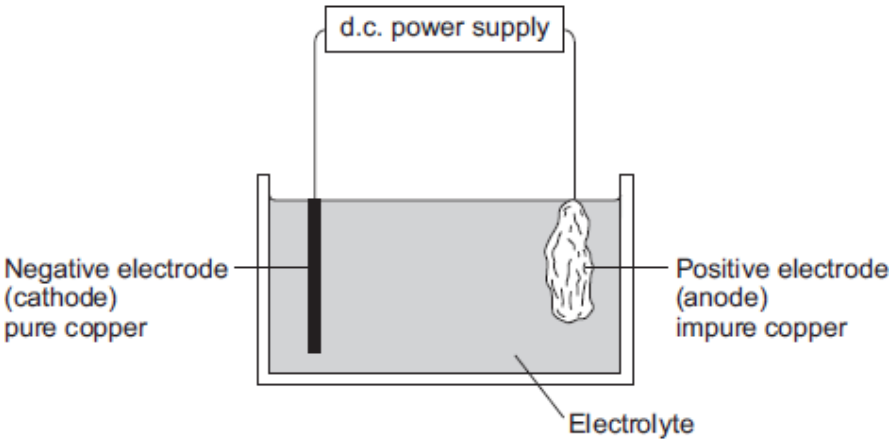
.....

.....

.....

(2)

(b) The impure copper produced by smelting is purified by electrolysis, as shown below.



Copper atoms are oxidised at the positive electrode to Cu^{2+} ions, as shown in the half equation.

$$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^{-}$$

(i) How does the half equation show that copper atoms are oxidised?

.....

.....

(1)

(ii) The Cu^{2+} ions are attracted to the negative electrode, where they are reduced to produce copper atoms.

Write a balanced half equation for the reaction at the negative electrode.

.....

(1)

(iii) Suggest a suitable electrolyte for the electrolysis.

.....

(1)

(c) Copper metal is used in electrical appliances.

Describe the bonding in a metal, and explain why metals conduct electricity.

.....

.....

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.....

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.....

.....

(4)

(d) Soil near copper mines is often contaminated with low percentages of copper compounds.

Phytomining is a new way to extract copper compounds from soil.

Describe how copper compounds are extracted by phytomining.

.....

.....

.....

.....

.....

.....

(3)

(e) A compound in a copper ore has the following percentage composition by mass:

55.6% copper, 16.4% iron, 28.0% sulfur.

Calculate the empirical formula of the compound.

Relative atomic masses (A_r): S = 32; Fe = 56; Cu = 63.5

You must show all of your working.

.....

.....

.....

.....

.....

.....

.....

.....

Empirical formula = ...

(4)

(Total 16 marks)

1

(a) (i) burning / breathing / respiration / fuels / food

for 1 mark each

2

(ii) 1. rock is heated / subducted (owtte) / close to magma / melted
1. rock is decomposed / carbon dioxide released through volcanoes

for 1 mark each

2

(b) carbon dioxide reacts / dissolves in sea-water / dissolves in rain water
insoluble carbonates / calcium carbonate are / is formed carbon dioxide turned into shells / coral / limestone / chalk / sediments also soluble hydrogencarbonates (calcium / magnesium) are formed photosynthesis by plants

any three for 1 mark each

3

(c) (i) sea unable to absorb all the extra carbon dioxide being produced
more trees being cut down / deforestation increased burning of fuels / more cars / more industry (*not* more people)

any one for 1 mark

1

(ii) global warming / greenhouse effect or effects such as melting ice caps / rising sea levels / climatic change / more deserts
(*not* changes to ozone layer)

for one mark

1

[9]

2

nitrogen – Gas A (or N_2) (N) = 1)
oxygen – Gas B (or O_2) (O)

for 1 mark each

[2]

3

(a) (i) nitrogen (gas) **or** N_2

if only the formula is given it must be correct in every detail

1

(ii) argon (gas) **or** Ar

1

(iii) oxygen (gas) **or** O_2

1

(b) vapour

1

evaporating

1

sea(s)

1

condenses

1

(c) volcanoes **or** volcanic activity **or** the sea(s)

allow carbonates(s) (rocks)

do not credit inside

1

[8]

-

4

(a) amount of CO_2 (much) lower
amount of O_2 (much) higher
amount of N_2 (much) higher (owtte.)
less other gases/less NH_3/less CH_4

any 2 for 2 marks

2

(b) 4 points from:
plants (evolved)/photosynthesis/algae
take in CO_2
give out O_2
water vapour condensed
ozone formed from oxygen
less CO_2 is produced now from volcanic activity
CO_2 from air trapped in sedimentary rocks or fossil fuels
nitrogen produced by bacteria/living organisms/microbes/decay of dead organisms (**not** nitrifying bacteria, nitrogen fixing 4 bacteria)
nitrogen produced by reaction of NH_3 with O_2/decomposition of NH_3
nitrogen builds up because it is unreactive
(Assume answer refers to today's atmosphere)

any 4 for 1 mark each

4

[6]

5

(a) (i) (gases from) volcanoes

1

(ii) 100 allow 99

1

(iii) any **two** from:

- photosynthesis
- carbon dioxide used
  allow carbon dioxide decreased
- oxygen produced
  allow oxygen increased
  ignore nitrogen / respiration
  they = plants

2

(b) (i) any **one** from:

- sea floor spreading
  accept oceanic ridges / magnetic stripes
- periodic measurements between continents
  accept continents move a few centimetres each year
- evidence from rocks / fossils on different continents
  accept continents fit together
- new mountain ranges
  accept new islands

1

(ii) in the mantle

any **two** from:

- convection (currents) / movement
  *do **not** accept movement of the plates*
- radioactivity / radioactive decay / nuclear reactions

1

- releases heat / thermal energy
  accept heat from core

2

[8]

6 (a) respiration

combustion

***1** mark each*

2

(b) methane

water

__1__ mark each

accept steam

do __not__ accept natural gas for methane

do __not__ accept hydrogen oxide

2

(c) greenhouse effect (increased)

accept (global) warming

accept polar ice caps melt

accept rising sea levels

accept problems with climatic change

do __not__ accept changes to the weather __or__ acid rain

1

[5]

7

Quality of written communication:

for correct sequencing or linking of __two__ ideas or __two__ points

annotate Q ✓ or Q ✗

1

any **three** from:

ignore superfluous statements

- **B** is least energy efficient in terms of cost (kJ per p), so **A** = **C** = **D** in terms of cost **or B** is the most expensive in terms of energy efficiency
owtte

  accept __B__ is poor value for money / __B__ is most expensive
  one is insufficient for mark

- **D** is 1st, since gives only water as product **or** gives no harmful products / gases **or** there are no pollutants
owtte

- **A** is 2nd best, since produces CO_2 owtte

- **C** is 3rd, since gives SO_2 owtte

if no other marks, then __D A C B__ – based on energy per kJ per 100g only = __1__ mark and Q mark if 2 ideas are linked

3

[4]

8

(a) any **two** environmental problems with linked explanations

- global warming (1)
  accept effects of global warming

  caused by (formation of) carbon dioxide / greenhouse gas (1)
  ignore greenhouse effect

- acid rain (1)
  accept effects of acid rain
  ignore respiratory problems

  caused by (formation of) sulfur dioxide (1)
  accept sulfur oxide
  ignore sulfuric acid

- global dimming (1)
  ignore respiratory problems

  caused by (formation of) particles / particulates / fires / smoke / carbon / pm 10 (1)

- scarring of landscape (1)

  caused by mining / quarrying of coal (1)
  ignore ozone layer

max 4

(b) any **three** from:

- replant the trees / renewable / sustainable
  ignore reusable

- carbon dioxide is used by the trees / photosynthesis
  accept trees absorb carbon dioxide as they grow
  *do **not** allow respiration*

- it's a (continuous carbon) cycle
  accept 'carbon dioxide goes back into the air'
  accept trees use CO_2 which is released when trees are burnt

- no '<u>new</u>' carbon (dioxide) is produced **or**
  no locked up carbon (dioxide) is released
  accept no carbon (dioxide) from fossil fuels is produced

3

[7]

9

(a) (i) any **two** from:

- used by plants
  allow specific plants and algae
- used for photosynthesis
  ignore oxygen released / respiration
- absorbed / dissolved in oceans
  ignore oceans formed
- locked up in fossil fuels / limestone / sedimentary rocks

2

(ii) calcium carbonate / $CaCO_3$

1

decomposed / thermal decomposition
*do **not** allow reaction with oxygen*
accept quicklime / calcium oxide produced
*$CaCO_3 \rightarrow CaO + CO_2$ gains **2** marks*

1

(b) increasing (CO_2 or global warming)

1

more rapid increase recently

1

carbon dioxide causes global warming
*accept greenhouse gas **or***
climate change / sea level rising
***or** ice caps melting*
*do **not** accept ozone layer or acid rain or global dimming*

1

(c) (i) any **one** from:

- Wegener had no evidence / proof
  accept movement too slow to measure
- other scientists had different ideas / views
  accept continents / plates fixed or land bridge
- did not respect Wegener as a scientist / geologist

1

(ii) any **three** from:

- plates (move)
  ignore continents
- heat energy / radioactivity (causes)
- convection currents
- in mantle

3

[11]

10

(a) curve of best fit drawn through

or close to all of the points

1

(b) (i) 313

1

(ii) 1989 +/– 1

1

(c) concentration / amount of carbon dioxide has <u>increased</u>

1

recently the rate of increase is <u>increasing</u>

1

[5]

11

(a) (i) nitrogen / N_2

1

(ii) carbon dioxide / CO_2

1

(b) (i) humans / scientists had not evolved

accept it was billions / millions of years ago

allow too long ago

1

(ii) temperature is above 100°C **or** any water would evaporate / boil

accept Venus is too hot

1

(c) any **three** from:

- used by plants
- used for photosynthesis

  *accept plants take in carbon dioxide and give out oxygen for the first two bullet points ie **2** marks*
- dissolves in oceans / seas

  allow absorbs into oceans / seas
- used to form the shells / skeletons of marine organisms
- locked up as limestone / carbonates
- locked up as fossil fuels / oil / coal

3

[7]

12 (a) (i) 2,4 drawn (as dots / crosses / e^-)

1

(ii) Water (vapour) / steam

allow hydrogen oxide / H_2O

*do **not** accept hydroxide*

1

(b) any **two** pairs from:

carbon dioxide (1)

causes global warming (1)

allow greenhouse effect / climate change / sea level rise / melting of polar ice caps

or

carbon (particles) / soot (1)

allow particulates

causes global dimming (1)

allow blocks out sunlight / smog / prevents plant growth / causes breathing difficulties

or

carbon monoxide (1)

is toxic (1)

or

sulfur dioxide (1)

causes acid rain (1)

allow kills plants / erosion / acidifies water

4

[6]

13 (a) (i) *it = water vapour*

condensed

accept temperature went <u>below</u> <u>100</u>°C / boiling point of water

allow <u>cooled to form liquid</u> / water / rain

*do **not** accept evaporated*

1

formed the oceans / seas

ignore rain

*accept (water vapour) cooled and formed the ocean / sea for **2** marks*

1

(ii) any **two** from:

ignore oxygen / nitrogen increased

ignore reference to volcanoes / respiration

- used by (green) plants / *algae*
  accept photosynthesis / plants give out oxygen
- changed into oxygen
- dissolved in oceans / seas
  accept (locked up) in shells / skeletons (of animals)
- (locked up) in carbonates / sedimentary rocks
- (locked up) in fossil fuels / named fossil fuel

2

(b) (i) cannot get to / reach / drill to / see the core

accept the core is (too) far down (into the Earth) / do not know what happens under the crust / Earth's surface

accept it is (too) hot / radioactive

ignore lack of evidence unqualified

1

(ii) any **three** from:

- heat / *energy* released
- from radioactive decay / processes
  accept radioactivity / nuclear reactions
- (causing) convection currents
- in the mantle

3

[8]

14

(a) acid rain → sulfur dioxide

1

global warming → carbon dioxide

1

global dimming → carbon particles

1

(b) (i) oxygen

1

(ii) carbon monoxide

1

(c) (i) decreasing

accept running out / none left

1

(ii) any **two** from:

it = coal

- world needs (more) energy
  accept population is increasing
  allow (greater) demand for coal / fuels / energy
- plentiful supply
  accept readily available
  allow coal will 'last longer'
- (many) countries have coal
- easy to find / extract
- oil / gas is running out
  accept need to use less oil / gas
  accept need to use it to replace oil / gas
- cheap **or** cheaper than oil

2

[8]

15 (a) (thought to cause) global warming / green house (effect) / climate change

ignore other consequences of global warming

*do **not** accept acid rain / ozone layer / global dimming*

1

(b) any **three** from:

- replant trees / renewable / sustainable
  ignore reusable
- carbon (dioxide) used by trees / photosynthesis
  accept trees absorb carbon (dioxide) as they grow
  ignore respiration
- it is a (continuous / carbon) cycle
  accept burning wood is carbon neutral

  or
  carbon (dioxide) goes back into the air
  *for the **second** and **third** bullet points: accept trees use carbon dioxide which is released when (trees / wood are / is) burnt for **2** marks*
- no new carbon (dioxide) is produced

  or
  no locked up carbon (dioxide) is released

  or
  the carbon (dioxide) was absorbed millions of years ago

3

[4]

16

(a) argon / Ar

1

(b) (i) 0

1

(ii) unreactive

1

(c) (i) 94.96(%)

1

(ii) any **two** from:

- plants or photosynthesis
- absorbed in oceans / *seas*
  *allow oceans store **or** take in **or** dissolve carbon dioxide*
- locked up in (sedimentary) rocks
- locked up in fossil fuels

2

[6]

17

(a) (i) H_2O
must be formula

1

CaO

must be formula

1

(ii) carbon dioxide from the air / (Earth's early) atmosphere

it = carbon (dioxide)

accept carbon dioxide from millions of years ago

1

formed (sedimentary) rocks **or** fossil fuels

ignore trapped / stored

1

(b) (i) decreases rapidly at first

it = carbon (dioxide)

1

then slowly **or** levels off

allow both marks if the description is correct using either 'rapidly' ***or*** *'slowly'*

allow correct use of figures for either marking point

*if no other mark awarded, allow CO_2 decreased for **1** mark*

1

(ii) any **two** from:

it = carbon (dioxide)

accept photosynthesis

- used by plants
- dissolved in oceans
- 'locked up' in fossil fuels **or** formed fossil fuels
- 'locked up' in rocks **or** formed rocks

2

(c) (yes)

it = percentage of carbon (dioxide)

ignore yes or no

because the percentage of carbon dioxide is increasing

1

which causes global warming (to increase)

allow (carbon dioxide) causes greenhouse effect/climate change

1

or

(no)

because the percentage of carbon dioxide is low (1)

compared to millions of years ago (1)

allow global warming can be caused by other factors (e.g. Sun / water vapour / methane)

[10]

18 (a) bar drawn correctly 78 – 80 (%)

1

(b) (i) (Mars has) no (green / living) plants / trees

1

(ii) (argon) is unreactive / inert

accept argon is a noble gas

ignore it is in Group 0

1

(c) (the amount of carbon dioxide has decreased because it has been) absorbed / used by (green / living) plants / trees **or** used for photosynthesis

accept dissolved / absorbed by oceans or locked up in fossil fuels / carbonate rocks

1

(d) the eruption of volcanoes

1

[5]

19 (a) any **two** from:

asks for cause therefore no marks for just describing the change

must link reason to a correct change in a gas

carbon dioxide has decreased due to:

accept idea of 'used' to indicate a decrease

- plants / microorganisms / bacteria / vegetation / trees
- photosynthesis

  ignore respiration
- 'locked up' in (sedimentary) rocks / carbonates / fossil fuels
- dissolved in oceans

  ignore volcanoes

oxygen has increased due to:

accept idea of 'given out / produced'

- plants / bacteria / microorganisms / vegetation / trees
- photosynthesis

  ignore respiration

nitrogen increased due to:

accept idea of 'given out / produced'

- ammonia reacted with oxygen
- bacteria / micro organisms

  ignore (increase in) use of fossil fuels / deforestation

2

(b) (because methane's) boiling point is greater than the average / surface temperature **or** Titan's (average / surface) temperature is below methane's boiling point

*ignore references to nitrogen **or** water*

1

any methane that evaporates will condense

accept boils for evaporates

accept cooling and produce rain for condensing

1

(c) C_nH_{2n}

1

[5]

20 (a) Methane

1

(b) Sea levels rising

1

(c) Burning of fossil fuels

1

(d) carbon dioxide concentration stayed constant from 1850 to 1900

1

carbon dioxide concentration slowly increased from 1900

1

carbon dioxide concentration increased more rapidly from 1965

allow values from 1965 − 1975

1

[6]

21

(a) any **one** from:

- not enough evidence or proof

  allow no evidence or no proof
- (life and the Earth were created) billions of years ago

  allow a long time ago

  ignore different beliefs or no one was there.

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

0 marks
No relevant content

Level 1 (1−2 marks)
Statements based on diagrams

Level 2 (3−4 marks)
Description of how one change occurred

Level 3 (5−6 marks)
Descriptions of how at least two changes occurred

Examples of chemistry points made in the response could include:

Main changes

- oxygen increased because plants / algae developed and used carbon dioxide for photosynthesis / growth producing oxygen; carbon dioxide decreased because of this
- carbon dioxide decreased because oceans formed and dissolved / absorbed carbon dioxide; carbon dioxide became locked up in sedimentary / carbonate rocks and / or fossil fuels
- oceans formed because the Earth / water vapour cooled and water vapour in the atmosphere condensed
- continents formed because the Earth cooled forming a supercontinent / Pangaea which formed the separate continents
- volcanoes reduced because the Earth cooled forming a crust.

Other changes

- nitrogen has formed because ammonia in the Earth's early atmosphere reacted with oxygen / denitrifying bacteria.

6

[7]

22 (a) any **one** from:

- complex systems
- many different variables
- many alternative theories

1

(b) carbon dioxide allows short wavelength radiation to pass through

allow greenhouse gas(es) for carbon dioxide

1

the atmosphere to the Earth's surface

1

carbon dioxide absorbs outgoing long wavelength radiation

1

(c) general increase in temperature caused by increase in greenhouse gases

1

any **two** human activities correctly linked to a named greenhouse gas

eg

increased burning of fossil fuels causes more carbon dioxide

2

deforestation causes more carbon dioxide

more cattle production causes more methane

use of landfill causes more methane

[7]

23 (a) Sulfur dioxide causes acid rain.

1

(b) red / orange / yellow

*do **not** accept any other colours*

1

because sulfur dioxide (when in solution) is an acid

1

(c) (there are) <u>weak</u> forces (of attraction)

*do **not** accept any reference to covalent bonds breaking*

1

between the molecules

*do **not** accept any other particles*

1

(these) take little energy to overcome

award third mark only if first mark given

1

(d) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1 – 2 marks)
A relevant comment is made about the data.

Level 2 (3 – 4 marks)
Relevant comparisons have been made, and an attempt made at a conclusion.

Level 3 (5 – 6 marks)
Relevant, detailed comparisons made and a justified conclusion given.

examples of the points made in the response

effectiveness

- W removes the most sulfur dioxide
- D removes the least sulfur dioxide

material used

- Both W and D use calcium carbonate
- Calcium carbonate is obtained by quarrying which will create scars on landscape / destroy habitats
- D requires thermal decomposition, this requires energy
- D produces carbon dioxide which may cause global warming / climate change
- S uses sea water, this is readily available / cheap

waste materials

- W product can be sold / is useful
- W makes carbon dioxide which may cause global warming / climate change
- D waste fill landfill sites
- S returned to sea / may pollute sea / easy to dispose of

6

[12]

24

(a) the Earth's (surface) temperature was high **or** at/above 100 °C

*allow the Earth's (surface) temperature was too / very hot **or** water evaporated / boiled **or** turned to steam / gas*

allow because of heat from volcanoes

ignore the Earth's (surface) was covered by volcanoes

ignore water turned to water vapour

1

(b) (i) air ——————— mixture

1

carbon dioxide ——— compound

1

argon ——————— element

1

allow only one line from each substance

(ii) oxygen

1

(iii) about 80 %

1

(c) (i) 0.03(0) (%)

1

(ii) increased

1

slowly then rapidly

1

allow figures from graph to indicate increase

(iii) any **two** from:

- use of fossil fuels
- deforestation
  allow less trees / plants
- cars/transport
- industry/factories
  ignore more people

2

[11]

25

(a) because sulfur dioxide causes <u>acid rain</u>

1

which kills fish / aquatic life **or** dissolves / damages statues / stonework **or** kills / stunts growth of trees

if no other mark awarded then award 1 mark for sulfur dioxide is toxic or causes breathing difficulties.

1

(b) (i) <u>electrons</u> are lost

1

(ii) $Cu^{2+} + 2e^{-} \rightarrow Cu$

allow $Cu^{2+} \rightarrow Cu - 2e^{-}$

ignore state symbols

1

(iii) copper sulfate

allow any ionic copper compound

1

(c) (lattice of) positive ions

1

delocalised electrons

accept sea of electrons

1

(electrostatic) attraction between the positive ions and the electrons

1

electrons can move through the metal / structure **or** can flow

allow electrons can carry charge through the metal / structure

if wrong bonding named or described or attraction between oppositely charged ions then do not award M1 or M3 − MAX 2

1

(d) (copper compounds are absorbed / taken up by) plants

allow crops

1

which are burned

1

the ash contains the copper compounds

do not award M3 if the ash contains copper (metal)

1

(e)

/ A_r	55.6 / 63.5	16.4 / 56	28.0 / 32
moles	0.876	0.293	0.875
ratio	3	1	3
formula	Cu_3FeS_3		

*award **4** marks for Cu_3FeS_3 with some correct working*

*award **3** marks for Cu_3FeS_3 with **no** working*

*if the answer is not Cu_3FeS_3 award up to **3** marks for correct steps from the table apply ecf*

*if the student has inverted the fractions award **3** marks for an answer of $CuFe_3S$*

4

[16]

Examiner reports

1

In part (a)(i) the vast majority of candidates gained both marks for stating the carbon dioxide is released by the burning of fossil fuels. A number of candidates stated that carbon dioxide is released by respiration which gained them one mark but to gain the second mark a reference was required to the 'fuel' involved in this process, food. Part (a)(ii) was less well answered with many candidates confusing geological activity with weathering or the effects or acid rain on carbonate rocks.

To gain the first mark some reference was required to the geological process acting upon the rock. It was hoped that the candidates would state the idea given in the syllabus that the rock is moved deep into the Earth but other answers such as the idea of the rock being heated were accepted. For the second mark it was hoped that candidates would state the idea given in the syllabus that the carbon dioxide is released via volcanoes but other answers such as the idea of the decomposition of the carbonate rock were accepted. Many vague references were made to volcanoes which could not be awarded marks. Some candidates thought that Earth movements exposed the carbonate rock to the air where the carbon in the rock would react with oxygen.

In part (b) few gained the three marks for ideas directly from the syllabus that the seawater reacts with/dissolves the carbon dioxide and forms insoluble carbonates and soluble hydrogencarbonates. A variety of other responses were accepted including one given by many candidates that plants in the sea use carbon dioxide during photosynthesis. In general most candidates were able to gain some of the marks for this question.

Part (c) was well answered. A number of candidates lost the mark in part (c)(i) because they simply repeated their answer to (a)(i), burning fossil fuels. To gain this mark there had to be some indication that more fossil fuels are being burned. The idea of global warming was well known in part (c)(ii) although a few candidates still confuse this with damage to the ozone layer.

2

A surprisingly large number of candidates were unable to identify the two main gases in the air. Some were able to identify the two gases but thought that gas A was oxygen and gas B nitrogen. Others gave a wide range of answers of which the commonest were hydrogen and carbon dioxide.

3

Most candidates included carbon dioxide somewhere on the pie chart. Argon hardly ever featured.

-

4

This question was often very well answered. Candidates frequently scored both marks in part (a) and at least three of the four marks in part (b). A few candidates failed to explain how the atmosphere today is different to that of billions of years ago and simply described the atmosphere as it is today. In part (b) candidates usually gained marks for describing the role of plants in the evolution of the atmosphere. Fewer candidates described the formation of nitrogen or ozone. Some candidates confused photosynthesis with respiration. A few candidates misread the question and described how pollution is changing the atmosphere today.

5

(a) (i) Most candidates did not know that the Earth's early atmosphere came from volcanoes.

(ii) Better candidates had no problem with the oceans forming when the temperature dropped to 100°C. A common answer was 99°C and this was accepted, as the candidate was presumably thinking that the temperature had dropped below 100°C, the boiling point of water.

(iii) The effect of the evolution of plants on the atmosphere was well answered, although many still refer to the process as respiration rather than photosynthesis. If the candidates use chemical equations instead of a description of a process then the equation must be correct.

(b) (i) The range of evidence that led to the acceptance of Wegener's ideas was very good, although there were vague answers referring to volcanoes and earthquakes that were not sufficient to gain the mark. Some candidates think that we can see the Earth's tectonic plates moving.

(ii) The explanation of the movement of the Earth's tectonic plates produced good answers with most candidates gaining at least two marks.

6

Double Award only

Most responses were correct in part (a), although 'decomposition' was often suggested instead of combustion'. Methane was identified correctly by the more able candidates, with 'carbon hydroxide', carbon hydrate' and 'hydrocarbon' being common incorrect answers. However, more than expected could not name water as the product. Part (c) was well answered. Frequent wrong answers included not having enough oxygen to breathe and damage to the ozone layer.

7

Few good answers were seen and ideas were often poorly expressed. Few candidates mentioned energy efficiency in terms of cost but referred to the gaseous products. The most common answer was based on the energy of the fuels in kJ per 100g, which gave the correct order. The mark for quality of written communication was only awarded occasionally.

8

The stem of part (a) did state that coal contains both carbon and sulfur. However, a small number of candidates only addressed one of them. Many candidates did not realise that a chemical reaction occurs between the sulfur and the carbon in coal, with oxygen from air. Many left them as carbon and sulfur and simply stated carbon and sulfur are given off. Several candidates scored well on this question with carbon dioxide causing global warming and sulphur dioxide causing acid rain as the most common correct explanation. A common misconception is that a greenhouse gas and the greenhouse effect are environmental problems. The problem is global warming and its effects. References to the mining of coal and the effect on the landscape were rare but, nevertheless, gained credit. Comments such as bad for the environment or cause pollution did not gain credit because they do not explain why burning coal causes environmental problems.

The most common response to part (b) scored only two marks for saying that although wood released carbon dioxide into the atmosphere when burnt, the tree had taken in the same amount while it was growing and so it is carbon neutral. Some went on to score the third mark by mentioning that the trees were renewable or could be replanted or sustainable. Most candidates did not appreciate that this neutrality will only work if new trees are planted to absorb the carbon dioxide emitted, else the forest would be completely cut down eventually. Very few candidates appreciate that coal burning releases carbon that has been locked away for millions of years. A common misconception was that wood does not release any or as much carbon dioxide as coal. Additionally a worrying number asserted that wood did not contain carbon so would not cause any pollution. Some candidates thought that carbon dioxide was locked away in trees meaning that when wood burns no carbon dioxide is produced.

9

(a) (i) This question was well answered with a majority of candidates gaining both marks. The most common correct response was that the carbon dioxide in the Earth's early atmosphere was removed by 'photosynthesis in plants'; also 'absorption of carbon dioxide by the oceans' and 'carbon dioxide being locked in sedimentary rocks' was quite well known. Incorrect responses included the loss of carbon dioxide through 'holes in the atmosphere' or 'holes in the ozone layer' and the fairly common statement that the decrease in the number of volcanoes led to a decrease in carbon dioxide levels. There are still many candidates who incorrectly write the formula for carbon dioxide as CO_2, Co_2 or CO2 and many who confuse 'photosynthesis' with 'respiration' or even with 'breathing'.

(ii) The release of carbon dioxide by thermal decomposition of limestone was quite well known. More able candidates also gained the first mark for stating that limestone is calcium carbonate. A correct chemical equation, which gained both marks, was occasionally present. However, there were many responses that just repeated the information given, such as 'locked up carbon dioxide is released when limestone is heated' or more simply 'when heated limestone gives off carbon dioxide.' Many weaker candidates thought that the limestone reacted with oxygen to produce carbon dioxide.

(b) Candidates gained one mark for stating that there was an increase in carbon dioxide levels and often gained a second mark for the link to global warming. Many candidates then went into a detailed explanation of the mechanism of global warming and some of its consequences. The final mark for the accelerating rate of increase of carbon dioxide levels was usually earned by most able candidates giving detailed answers. A significant number of candidates lost the global warming mark by reference to the 'ozone layer' or 'global dimming' or 'acid rain'. A similar number gave general consequences such as 'it will harm the environment'. Some candidates thought that the increase in carbon dioxide levels was so severe that if it continued it would lead to the oxygen levels in the atmosphere falling alarmingly so that all humans would suffocate.

(c) (i) This was very well answered, with 'no evidence' or 'no proof' the most common responses. However, ideas of land bridges and the lack of respect for Wegener amongst geologists at the time were also quite well known.

(ii) This question was a good discriminator. Most candidates gained two marks for the mention of 'plates moving' and 'in the mantle'. A small majority of candidates gained all three marks because they understood that heat released by radioactivity produced convections currents within the mantle and these caused the Earth's plates/continents to move.

10

In part (a) to many candidates a line of best fit meant a straight line. To gain the mark candidates were expected to draw a curve which passed through or was close to all of the points.

In part (b) many candidates correctly read off the concentration of carbon dioxide. It was still possible to give the correct year in part (b)(ii), even if the curve had not been drawn correctly.

In part (c) the majority of candidates realised the carbon dioxide concentration was rising. A reasonable number of candidates also described the increasing rate of increase after about 1935 for the second mark.

11

(a) (i) A large number of candidates used the information provided to correctly identify nitrogen as the main gas in the Earth's atmosphere.

(ii) The majority of candidates realised from the data that carbon dioxide used to be the main gas in the Earth's atmosphere.

(b) (i) Most responses were incorrect because they were based on the idea that there was a lack of valid evidence which was caused by inadequate technology or the composition of the atmosphere changing.

(ii) Many candidates recognised that liquid water would not exist on the surface of Venus because it was too hot or any liquid water would boil/evaporate. Simply to state that the temperature on Venus is 460°C is an incomplete explanation and did not receive credit.

(c) The diagram was given to cue candidates into how carbon dioxide was removed from the Earth's early atmosphere. Many candidates gained two marks for stating that trees absorb carbon dioxide and give out oxygen. Several of these candidates also appreciated that carbon dioxide was dissolved into the oceans. There was evidence that the majority of candidates do not understand that a large proportion of this carbon dioxide gradually became locked up in sedimentary rocks as carbonates and fossil fuels.

12

(a) (i) This was well answered. Most students used dots or crosses to represent the electronic structure of a carbon atom. Some students decided to change their original answer; so at times it was difficult to tell whether an electron had been crossed out or not. The most common errors were putting more than 2 electrons in the first shell or more than 4 electrons in the outer shell.

(ii) Most students knew that hydrogen reacts with oxygen to produce water. The most common incorrect answer was 'hydroxide'.

(b) This was generally answered well. Many students gained full marks by going down the route of 'carbon dioxide causes global warming and sulfur dioxide causes acid rain'. Credit was awarded for a stated correct consequence of an environmental impact instead of the name of the environmental impact. Students who could not express themselves clearly lost marks particularly either when they did not realise that carbon and sulfur reacted with oxygen to produce oxides or when they did not link a product to its environmental impact. A few students confused global dimming with global warming. It was fairly common for weaker students to lose a mark by referring to a product causing damage to the ozone layer. Some students named more than two products that often included incorrect substances, so they lost marks because of the list principle.

13

(a) (i) This part was poorly answered with very few candidates gaining even one mark. Often candidates assumed that the water vapour could be converted into a different gas, such as oxygen or nitrogen. Other candidates did not appreciate the time interval between the Earth's early atmosphere and the Earth's atmosphere today and thought that the water vaporised and disappeared at the high temperature (400^{o}C) on the Earth's surface.

(ii) This part was poorly answered with very few candidates gaining both marks. By far the most common correct response was that plants use carbon dioxide and change it into oxygen, although several candidates stated that plants breathed in or sucked in carbon dioxide. Reduced volcanic activity was the most common incorrect answer. Again there was an unexplained change of carbon dioxide into a different gas, such as oxygen or nitrogen. Very few candidates knew that carbon dioxide dissolves in sea water.

(b) (i) This question was well answered with a majority of candidates realising that the Earth's core is inaccessible. However, the lack of evidence comment with no explanation did not gain any credit.

(ii) This question was poorly answered by candidates. A few candidates gained two marks for realising that the controversial theory involved convection currents in the mantle. Some candidates mentioned radioactive processes but many of these thought that these processes would cause nuclear explosions causing thetectonic plates to move.

14

(a) Most candidates followed the instruction and drew one straight line from each possible environmental problem to the correct emission that caused the problem, with most candidates scoring all three marks.

(b) (i) The fact that incomplete combustion of oil or coal is caused by too little oxygen was known by most candidates.

(ii) The knowledge that incomplete combustion of oil or coal leads to the formation of carbon monoxide was known by most candidates.

(c) (i) Most candidates answered correctly that the world production of oil was predicted to decrease. However there were a few candidates who when they looked at the years 2000 to 2200, wrote that production would increase because 2200 is a higher number than 2000.

(ii) Most of the reasons that gained credit were based on the idea that oil is running out and that there is a lot of coal available. It was apparent from some of the responses that many candidates did not know that coal was a fossil fuel. These candidates thought that coal was renewable and could be reformed from decaying plants within a period of a few years. Many candidates thought that coal was less polluting than oil.

15

(a) Concerns about carbon footprints were well understood.

(b) Most candidates understood that burning wood would have a lower carbon footprint than burning coal. Weaker candidates did not write a full explanation to gain all three marks. A significant minority thought that burning wood emits no carbon dioxide or blamed coals high carbon density for its carbon footprint.

16

(a) A high proportion of students gained the mark for knowing that argon is a noble gas.

(b) (i) A majority of students knew that noble gases are in Group 0 of the periodic table.

(ii) Just over half of the students knew that noble gases are unreactive.

(c) (i) Most students managed to correctly calculate the decrease in the percentage of carbon dioxide in the Earth's atmosphere was 94.96 %. The most common errors were answers of 95, 94.06 or 94.6 %.

(ii) Only a few students gained both marks. The reasons for the decrease in the percentage of carbon dioxide in the Earth's early atmosphere were not widely known. The most common correct reason was for the idea of plants or photosynthesis taking in carbon dioxide. Dissolving of carbon dioxide in oceans was rarely seen. The reason least often seen was that the carbon dioxide became locked up in sedimentary rocks and / or in fossil fuels. The reason often stated 'carbon dioxide is trapped in sedimentary rocks and / or in fossil fuels' is not creditworthy. A large number of students incorrectly thought the reasons were that there is less volcanic activity and people are aware of the impact of global warming so they are producing less carbon dioxide.

17

(a) (i) Although many completions of the chemical equations were correct, the question produced a wide variety of symbols and formulae.

(ii) The question was very poorly answered, with many students failing to grasp the idea of locked up carbon dioxide. Most seemed to miss the main point and instead focused on how the carbon dioxide would be released after being locked up, that is, referring to carbon dioxide which would be released into the atmosphere when fuels are burned.

(b) (i) The better students realised that the percentage decrease of carbon dioxide had slowed down in the last 4500 million years. Many students only gained the compensation mark for stating that levels of carbon dioxide had decreased. It was perhaps surprising that so many students read the graph as increasing levels of carbon dioxide, with some thinking that graph 1 related to an increase of carbon dioxide in the future.

(ii) A reasonable proportion of students described how the percentage of carbon dioxide has changed in the last 4500 million years, usually with reference to photosynthesis and carbon dioxide dissolving in oceans. However, many students still seem to think that respiration is the same as photosynthesis. Many students incorrectly related the percentage change of carbon dioxide to the present day with both increasing levels of carbon dioxide due to more transport and decreasing levels due to a lack of fossil fuels.

(c) The correct explanation for the change in carbon dioxide levels in the last 250 years mostly related to the argument that increasing levels would increase global warming. Another correct argument used was that it is not a concern at the moment because the level of carbon dioxide is still relatively low.

18

(a) Students should use a ruler to draw straight lines. Far too many students lost the mark because their lines were drawn free-hand and touched 76% or were above 80%. However, a few students did manage to get the mark. The most common mistake was to draw a line at 20%. Several students did not attempt this question.

(b) (i) The most common mark awarded was for 'there are no trees on Mars'. There were many incorrect ideas, such as, 'Mars has too much carbon dioxide so not enough space for oxygen', 'no humans to use oxygen' and 'Mars has no gravity so there is no atmosphere'.

(ii) There were very few correct responses indicating that argon is unreactive or that argon is a noble gas. Many stated that argon stays the same because it has no uses.

(c) Few students stated that the percentage of carbon dioxide had decreased because of 'photosynthesis by plants' or 'absorption by oceans' or 'locked up in fossil fuels' or 'locked up in carbonate rocks'. Many students appeared to have failed to notice the word **not** in the question and answered as if carbon dioxide was increasing. The more common incorrect answers were 'because we burn more fuels' and 'there are more humans breathing out carbon dioxide'.

(d) The majority of students knew that theories suggest that the Earth's early atmosphere was made by the eruption of volcanoes.

19

(a) The question of how the percentages of two gases in the Earth's early atmosphere have changed to the percentages in the Earth's atmosphere today was a good discriminator. The two most common correct answers were carbon dioxide and oxygen, both linked to photosynthesis.

(b) Given the boiling point of methane and the surface temperature on Titan most students could not explain why on Titan, it rains methane. The negative temperatures obviously caused problems for the majority of students.

(c) The general formula for alkenes was not well known.

21

(a) Only a few students mentioned a lack of evidence or proof. A lot of students still use comments, such as ‘no one was there’ or ‘religious beliefs’, in a variety of ways.

(b) This was the QC question, worth six marks. The stem contained quite a lot of useful information. The description and explanation were poorly done with a large number of students simply reproducing statements from the diagrams. Whilst there were no marks for simply repeating the information in the question, the vast majority of students could build on it to answer the question. Slightly under half of the students were marked as Level 2, most gaining 3 marks.

Students were asked to describe and explain how the surface of the early Earth and its atmosphere have changed. Level 1 answers were simple descriptions, for example that the carbon dioxide had decreased. Level 2 answers were expected to include simple links, for example carbon dioxide had decreased because green plants evolved. Level 3 answers were expected to include detailed links, for example carbon dioxide had decreased because green plants evolved and replaced carbon dioxide with oxygen, by photosynthesis. There was the usual confusion as to whether photosynthesis or respiration used carbon dioxide to produce oxygen.

Students organised their answers better than in the past, with most dealing with one change at a time. The reasons for the decrease in the percentage of carbon dioxide in the Earth’s early atmosphere were not widely known. The most common correct reason was for the idea of plants or photosynthesis taking in carbon dioxide. Dissolving of carbon dioxide in oceans was rarely seen. The reason least seen was that the carbon dioxide became locked up in sedimentary rocks and / or in fossil fuels. The reason often stated that ‘carbon dioxide is trapped in sedimentary rocks and / or in fossil fuels’ was not creditworthy. A large number of students incorrectly thought the reasons for a decrease in the percentage of carbon dioxide were that there is less volcanic activity and that people are aware of the impact of global warming so they are producing less carbon dioxide. The formation of oceans appeared in many answers but most of these did not include the idea of the Earth cooling and the water vapour condensing. There were a lot of answers concerning the formation of continents that were spoiled by the use of words ‘country’ or ‘island’ instead of continent. Students often seemed to be confused about the sequence of events when describing or explaining the formation of continents. There was the misconception that the separation of continents allowed water to flow up from within the Earth and form the oceans.

24

(a) Many students gained the mark for suggesting that the Earth’s temperature was high or above 100 °C or the water evaporated. A large number of students just stated that there were volcanoes without any mention of temperature. Others suggested that it was due to global warming.

(b) (i) This was reasonably answered with the majority of students gaining at least one mark. Most of the correct links were for argon as an element.

(ii) This was poorly answered. Many students had not read the question carefully and gave carbon dioxide as the gas used up when hydrocarbons burn.

(iii) The percentage of the atmosphere that is nitrogen was surprisingly poorly answered.

(c) (i) The majority of students gave the correct answer. The most common incorrect answer was 30 %.

(ii) The majority of students gained one mark for stating or using figures from the graph to show that the percentage of carbon dioxide increased. Only a few students went on to describe that the increase began slowly and then became more rapid. Many did not gain marks because they simply used the words ‘carbon dioxide percentage has changed’ from the stem and then described why, rather than how the percentages changed. Again many students did not read the question carefully and started their answer from the year 1800 instead of from the year 1900.

(iii) Many students stated that the change in the percentage of carbon dioxide was due to an increase in respiration because of a rising population. Of those who gave correct reasons most went for more transport and more industry. Again many students did not read the question carefully and gave answers related to why the percentage of carbon dioxide in the Earth’s early atmosphere had decreased.

25

(a) The majority of students were able to state that acid rain is formed and then give a correct consequence of acid rain. Some students simply stated that sulfur dioxide made rain water acidic − it is acidic naturally due to carbon dioxide dissolving in it, or gave vague statements such as it caused “pollution”. A few students blamed sulfur dioxide for causing just about every environmental problem of which they could think.

(b) (i) A small minority of students got the definitions of oxidation and reduction mixed up, and so despite the equation they were given they tried to say that the copper gained electrons. A few tried to explain oxidation in terms of oxygen gain, using some very inventive chemistry to tie it into the equation provided.

(ii) This was very often correct. The most common errors were to have the electrons on the wrong side or to have the electrons shown as having a positive charge.

(iii) This question was demanding. Common errors included suggested non-conductors as the electrolyte (such as distilled water), substances that did not contain copper ions (cryolite and brine were popular) or even molten copper.

(c) Most students gained the mark for stating that metals contained delocalised electrons, but addressed only the second part of the question, did not describe the bonding, and so did not refer to the positive ions nor the attraction between the positive ions and the electrons. There is some misunderstanding as to the role of electrons in the conduction of electricity, a significant number of students wrote about electrons being able to pass charge on from one electron to the next, not realising that the charge that is moving is the electrons themselves.
It was very common for students to fill all of the space provided, and so detailed explanations of malleability and melting point were very common. These had nothing to do with the question asked and so gained no marks.

(d) Only a small minority of students did not realise that the process had something to do with plants. However, as was the case the last time a question covering this part of the specification was asked, it was a common error to state that the ashes left contained copper rather than copper compounds.

(e) A small minority of students had little idea how to tackle this question, but for many it was a good source of marks. The most common errors were excessive rounding of numbers and careless slips; some of the slips were so obvious that if the candidate had checked their work through they should have been able to spot them. Students would be well advised to put words in their working, or to set it out in a table with headings that make it clear what they are doing because it can be difficult to award any marks for incorrect answers where the working is simply numbers.