AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.9.1.1

The proportions of different gases in the atmosphere

Past-paper questions

Tier	**Higher**
Question groups	**33**
Available paper years	**2007–2025**

Using this booklet

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

Name: _____ **Date:** _____

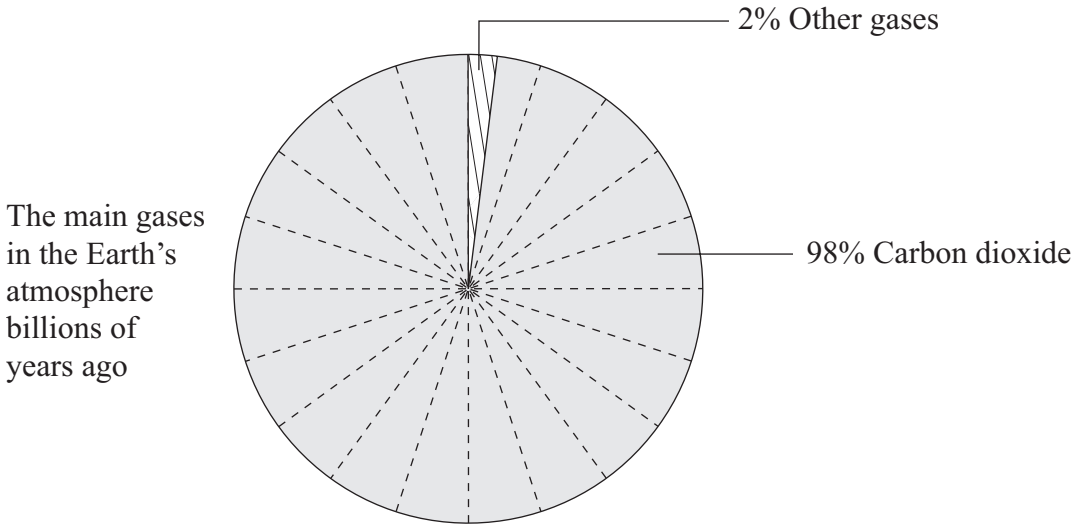
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.9.1.1 The proportions of different gases in the atmosphere

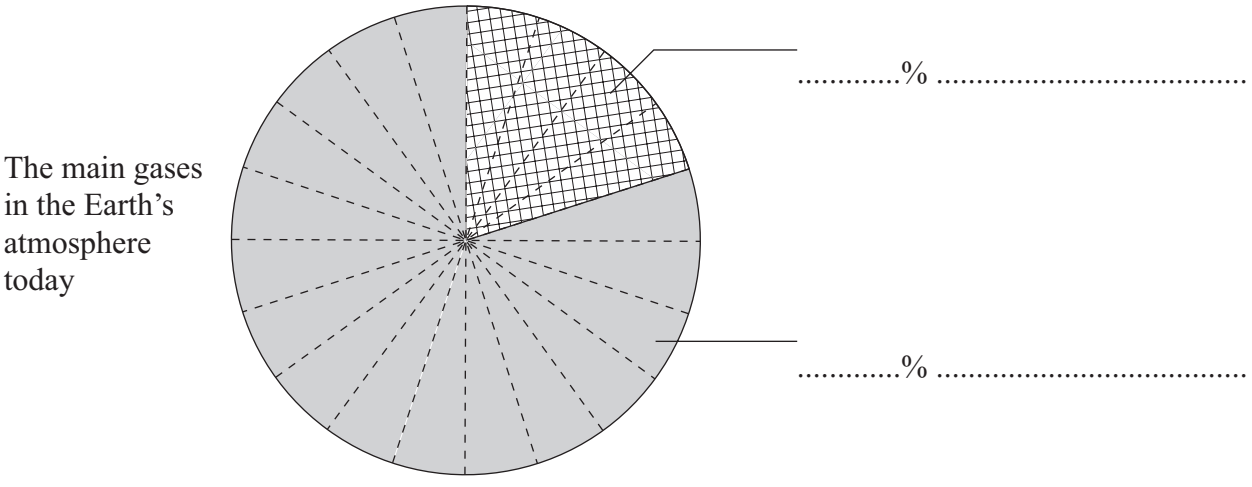
Question 01

January 2007 | CHY1H | Original Q2 | Legacy

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



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



(2 marks)

4.9.1.1 The proportions of different gases in the atmosphere

Question 01 · continued

BLANK

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

(i) What environmental problem does sulfur dioxide cause?

.....

.....

(1 mark)

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

.....

.....

(1 mark)

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

Complete the word equation for this reaction.

methane + ... → carbon dioxide + ...

(2 marks)

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

Explain why.

.....

.....

.....

.....

(2 marks)

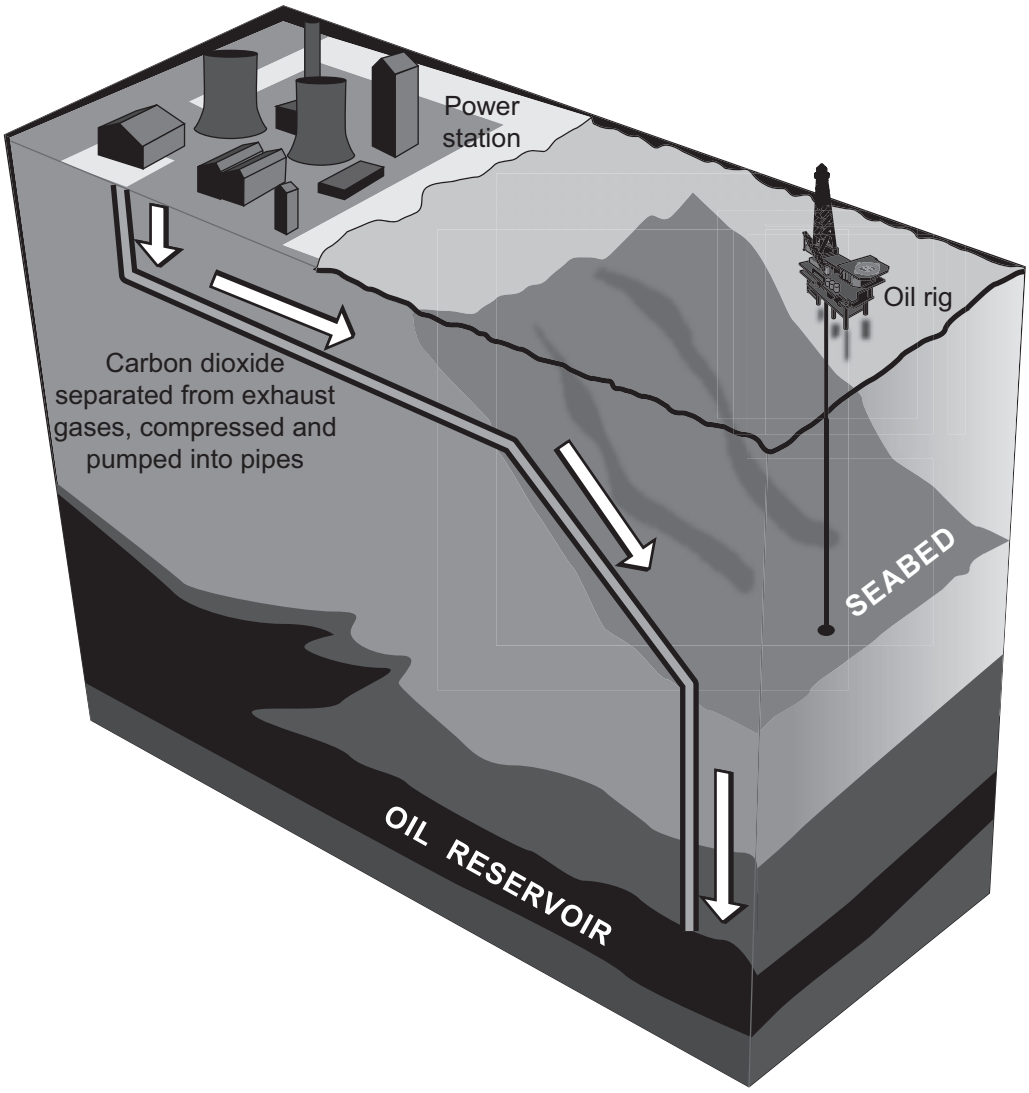
Question 2 continues on the next page

4.9.1.1 The proportions of different gases in the atmosphere

Question 01 · continued

BLANK

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



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

.....

.....

.....

.....

(2 marks)

10

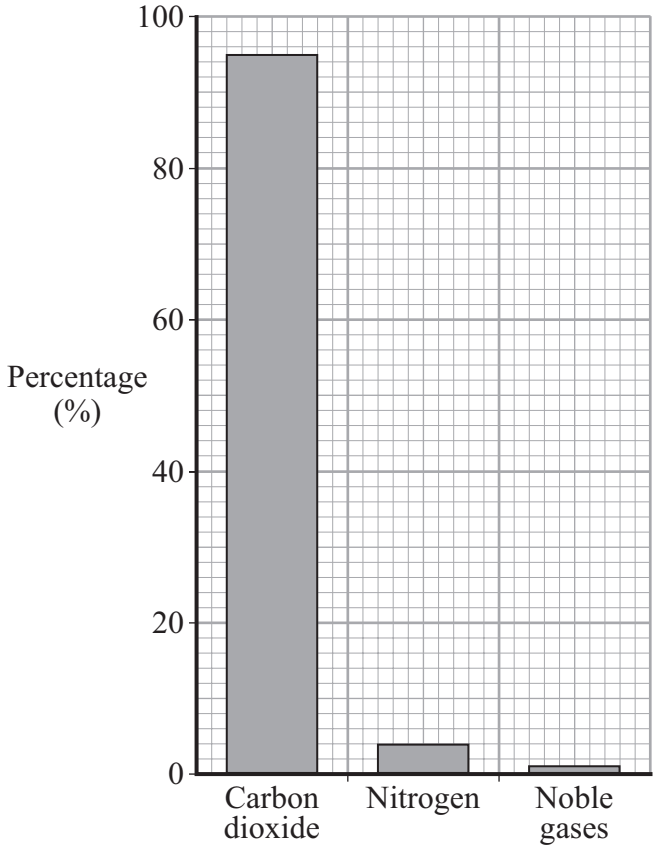
4.9.1.1 The proportions of different gases in the atmosphere

Question 02

June 2007 | CHY1B | Original Q5 | Legacy

QUESTION FIVE

The bar chart shows the composition of a sample of the atmosphere on Mars.



5A Earth's early atmosphere also contained a high percentage of carbon dioxide.

Scientists think that most of the carbon dioxide . . .

1 came out of solution from the oceans.

2 was released from volcanoes.

3 was given off as carbonate rocks decomposed.

4 was released as fossil fuels formed.

5B One way in which Earth's atmosphere today is different from that on Mars is that the Earth's atmosphere.. . .

1 contains less nitrogen.

2 contains more carbon dioxide.

3 does not contain noble gases.

4 contains more water vapour.

4.9.1.1 The proportions of different gases in the atmosphere

Question 02 · continued June 2007 | CHY1B | Original Q5 | Legacy

5C The first plants are thought to have appeared on Earth about 2 billion years ago.

What effect did the plants have on the Earth's atmosphere?

1 They increased the percentage of carbon dioxide.

2 They decreased the percentage of nitrogen.

3 They increased the percentage of oxygen.

4 They increased the percentage of ammonia.

5D Filament lamps are normally filled with a noble gas.

The metal filament in a lamp would quickly burn away if the bulb was filled with air because air contains . . .

1 carbon dioxide.

2 nitrogen.

3 oxygen.

4 ammonia.

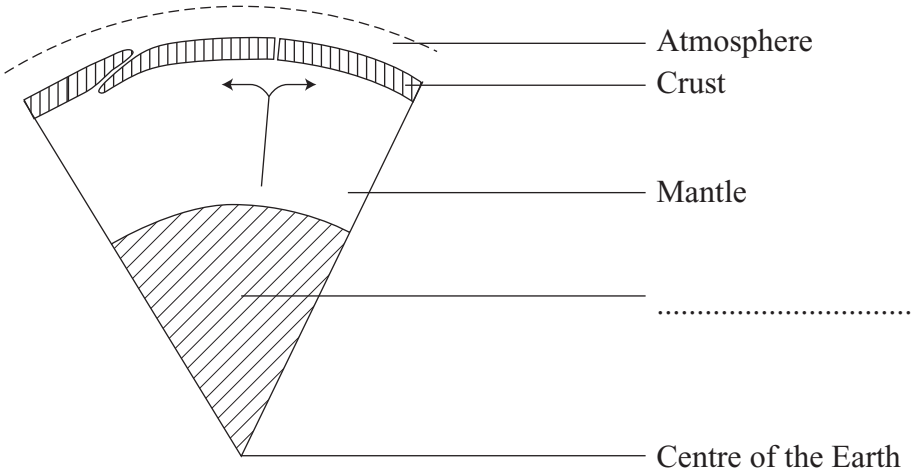
4.9.1.1 The proportions of different gases in the atmosphere

Question 03

June 2007 | CHY1H | Original Q3 | Legacy

3 The Earth is shaped like a sphere and is surrounded by an atmosphere.

(a) The diagram shows a section of the layered structure of the Earth.



Not to scale

(i) Complete the diagram by writing in the missing label. *(1 mark)*

(ii) Earthquakes within the Earth's crust can be sudden and disastrous. Scientists cannot accurately predict when earthquakes will occur.

Explain why.

To obtain full marks you must support your answer with a description of what causes earthquakes.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

4.9.1.1 The proportions of different gases in the atmosphere

Question 03 · continued

BLANK

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

Gases	The atmosphere of Mars today	The atmosphere of Earth today
Carbon dioxide %	95	0.03
Nitrogen %	3	
Argon %	1.5	0.97
Oxygen %	0.5	21

(i) Complete the table by writing in the percentage of nitrogen in the atmosphere of Earth today. *(1 mark)*

(ii) Use the information in the table to describe the changes that have happened to **two** of the gases in the Earth's atmosphere.

Explain what has caused these changes.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

10

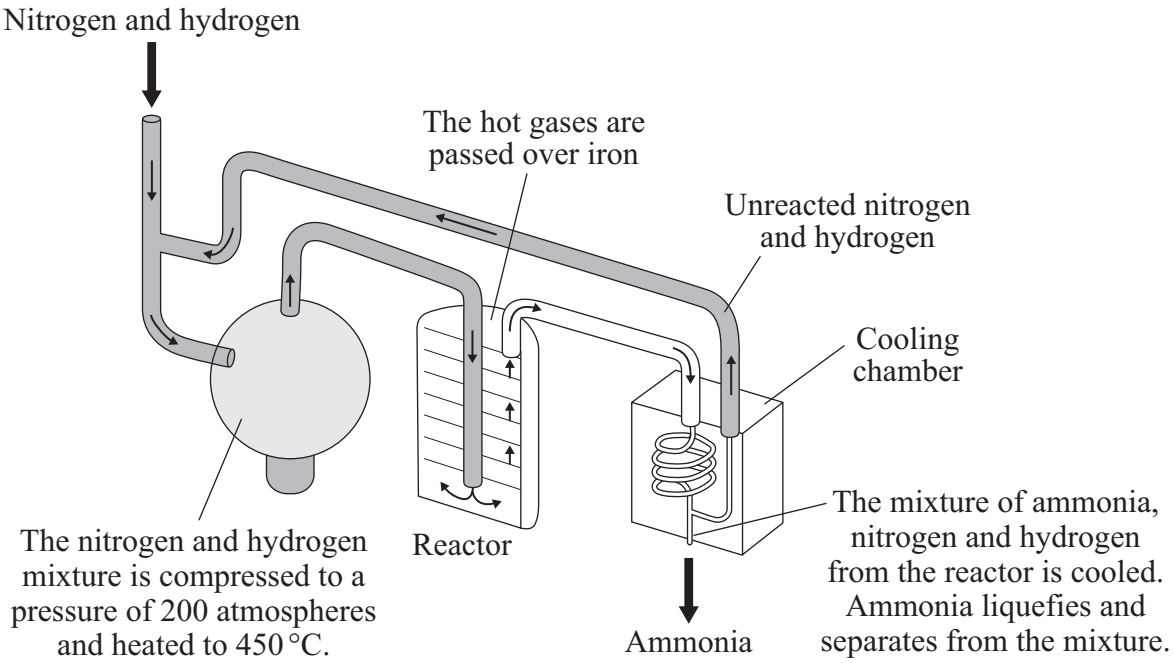
4.9.1.1 The proportions of different gases in the atmosphere

Question 04

January 2008 | CHY2H | Original Q7 | Legacy

7 The Haber process is named after the German chemist, Fritz Haber.

The diagram shows the main stages in the Haber process.



An exothermic reaction takes place when nitrogen reacts with hydrogen to make ammonia. The reaction can be represented by this equation.

$$N_2\,(g) \quad + \quad 3H_2\,(g) \quad \rightleftharpoons \quad 2NH_3\,(g)$$

(a) Calculate the maximum mass of ammonia that could be made from 1000 g of nitrogen.

Relative atomic masses: H = 1; N = 14

.....

.....

.....

.....

Mass .....g

(3 marks)

4.9.1.1 The proportions of different gases in the atmosphere

Question 04 · continued

BLANK

(b) At a temperature of 450 °C and 200 atmospheres the actual mass of ammonia produced when 1000 g of nitrogen is passed through the reactor is 304 g.

Calculate the percentage yield of ammonia produced in the reactor.

(If you did not answer part (a), then assume that the maximum mass of ammonia that can be made from 1000 g of nitrogen is 1100 g. This is **not** the correct answer to part (a).)

.....

.....

.....

.....

.....

Percentage yield of ammonia = ... %

(2 marks)

(c) State **and** explain:

(i) how a **decrease** in temperature would affect the yield of ammonia

.....

.....

.....

.....

(2 marks)

(ii) how an **increase** in pressure would affect the yield of ammonia.

.....

.....

.....

.....

(2 marks)

Question 7 continues on the next page

4.9.1.1 The proportions of different gases in the atmosphere

Question 04 · continued

BLANK

(d) Factories that make ammonia are often near to large towns.

Discuss the economic, safety and environmental factors to be considered when there is an ammonia factory near a town.

.....

.....

.....

.....

.....

.....

.....

(3 marks)

12

4.9.1.1 The proportions of different gases in the atmosphere

Question 05

March 2008 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

The diagram shows part of the Periodic Table of the elements published in 1869.

Groups

1	2	3	4	5	6	7
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca					

About 30 years later, five noble gases were discovered.

5A How were the noble gases fitted into the Periodic Table?

1 They were put one each into the first five groups.

2 They were put into Groups 3 to 7.

3 A new group was created for them.

4 They were not included in the table.

5B Which one of the following explains why it took so long to discover the noble gases?

1 They have only very recently been found in high concentrations on Earth.

2 They are of very low density and are therefore found only in the upper atmosphere.

3 They are chemically unreactive and therefore difficult to detect.

4 They are so like the other gases in the atmosphere that they are difficult to separate.

4.9.1.1 The proportions of different gases in the atmosphere

Question 05 · continued March 2008 | CHY1BP | Original Q5 | Legacy

The Earth's atmosphere contains about 0.9% argon.

5C How much argon is there in a room with a volume of 50 cubic metres?

1 $0.018\,m^3$

2 $1.80\,m^3$

3 $0.45\,m^3$

4 $4.50\,m^3$

5D Which one of the following correctly describes the use of argon in discharge tubes for advertising signs?

1 It is radioactive, giving out a coloured glow.

2 It gives out a coloured glow under high voltage.

3 It is chemically unreactive and therefore harmless if it escapes.

4 It is of very low density and helps to support the weight of the tube.

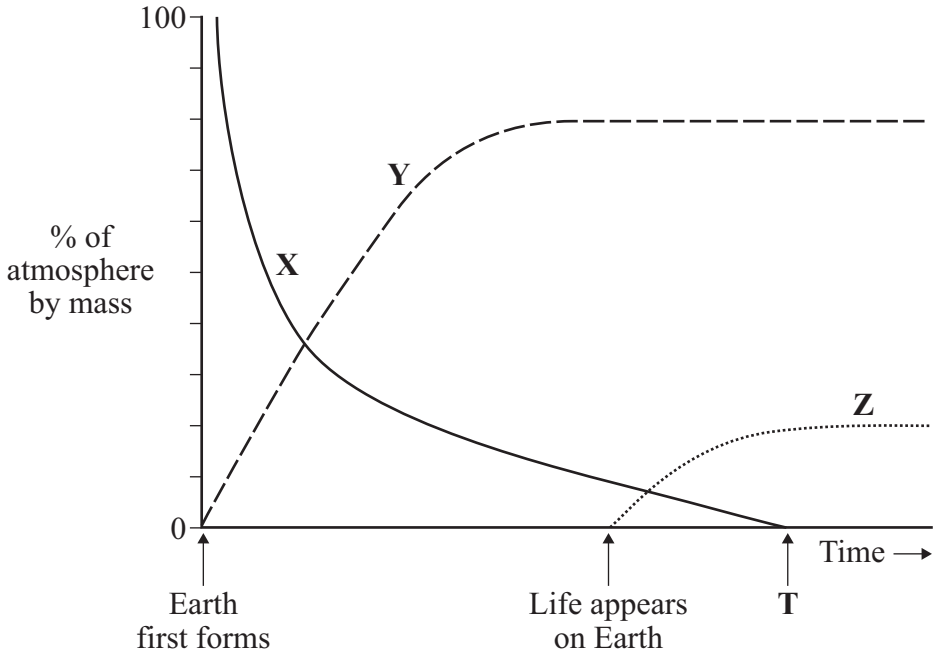
4.9.1.1 The proportions of different gases in the atmosphere

Question 06

March 2008 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

The diagram below shows how the levels of nitrogen, oxygen and carbon dioxide in the Earth's atmosphere have changed with time.



7A What is the ratio, by mass, of gas **Z** to gas **Y** at time **T**?

1 1:4

2 1:5

3 4:1

4 5:1

7B Which one of the following correctly matches the lines on the graph?

1 **X** is carbon dioxide, **Y** is nitrogen and **Z** is oxygen

2 **X** is oxygen, **Y** is nitrogen and **Z** is carbon dioxide

3 **X** is nitrogen, **Y** is oxygen and **Z** is carbon dioxide

4 **X** is carbon dioxide, **Y** is oxygen and **Z** is nitrogen

4.9.1.1 The proportions of different gases in the atmosphere

Question 06 · continued March 2008 | CHY1BP | Original Q7 | Legacy

7C During the last 200 million years, . . .

1 the burning of fossil fuels has decreased the proportion of oxygen in the Earth's atmosphere.

2 intense volcanic activity has substantially changed the atmosphere of the Earth.

3 the percentage of carbon dioxide in the Earth's atmosphere has decreased considerably.

4 the proportion of nitrogen in the Earth's atmosphere has remained fairly constant.

7D It is thought that there is no oxygen in the atmosphere of the planet Venus.

This is because . . .

1 animals used it up in respiration.

2 it is locked up in sedimentary rocks.

3 it is locked up in fossil fuels.

4 there are no plants to produce it by photosynthesis.

4.9.1.1 The proportions of different gases in the atmosphere

Question 07

June 2008 | CHY1BP | Original Q9 | Legacy

QUESTION NINE

9A There was little or no nitrogen in Earth's early atmosphere, but a gaseous compound of nitrogen was present in small amounts.

This gaseous compound is . . .

1 ammonia.

2 carbon dioxide.

3 methane.

4 sulfur dioxide.

In 1892, Lord Rayleigh compared nitrogen from the air with very pure nitrogen obtained from nitrogen compounds. The density of the nitrogen was:

nitrogen from the air	= 1.2572 grams per litre
nitrogen from nitrogen compounds	= 1.2511 grams per litre.

Rayleigh and Sir William Ramsay proved that atmospheric nitrogen was not pure but contained five other gases, which together made up about 1% of the Earth's atmosphere. The gases were argon (0.94%) and traces of helium, neon, krypton and xenon.

The five gases are similar in that they show no chemical reactions but have different physical properties, eg density, melting point, boiling point.

9B The main reason why scientists did **not** find these five gases in the atmosphere at an earlier date was that . . .

1 they have a very low density.

2 they are present in only small quantities.

3 they are unreactive.

4 they are colourless.

9C One way of separating the five gases from each other is by . . .

1 passing a mixture of the gases over heated carbon.

2 allowing them to settle, according to density, in a glass vessel.

3 fractional distillation of the mixture.

4 passing a mixture of the gases over a nickel catalyst.

4.9.1.1 The proportions of different gases in the atmosphere

Question 07 · continued

9D From the information given in the question, it is safe to predict that . . .

1 nitrogen makes up about 78% of the atmosphere.

2 argon has a density greater than the density of nitrogen.

3 neon, krypton and xenon have a density lower than the density of nitrogen.

4 nitrogen from nitrogen compounds must contain a very light gas such as hydrogen.

END OF TEST

4.9.1.1 The proportions of different gases in the atmosphere

Question 08

June 2008 | CHY1H | Original Q7 | Legacy

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

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

The table shows data about the atmospheres of Mars and Earth as they are now.

Mars		Earth	
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	

Suggest what has caused the main gases in the Earth's atmosphere of millions of years ago to change to the present-day atmosphere.

.....

.....

.....

.....

(2 marks)

7 (b) Titan is the largest moon of the planet Saturn. It has an atmosphere that, like the Earth's, 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! Explain why.

.....

.....

.....

(2 marks)

4.9.1.1 The proportions of different gases in the atmosphere

Question 08 · continued

for mark

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

7 (c) (i) Draw the structure of propene, C_3H_6, to show the covalent bonds.

(1 mark)

7 (c) (ii) Explain how propene molecules form a polymer. You should name the polymer formed.

.....

.....

.....

.....

.....

.....

(3 marks)

8

4.9.1.1 The proportions of different gases in the atmosphere

Question 09

November 2008 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

This question is about some gases found in the Earth's atmosphere.

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

A carbon dioxide

B helium

C nitrogen

D oxygen

1	It is in Group 0 of the periodic table.
2	It makes up about 80 % of the atmosphere.
3	It is found in today's atmosphere in much smaller amounts than in Earth's early atmosphere.
4	It is used when fossil fuels burn.

4.9.1.1 The proportions of different gases in the atmosphere

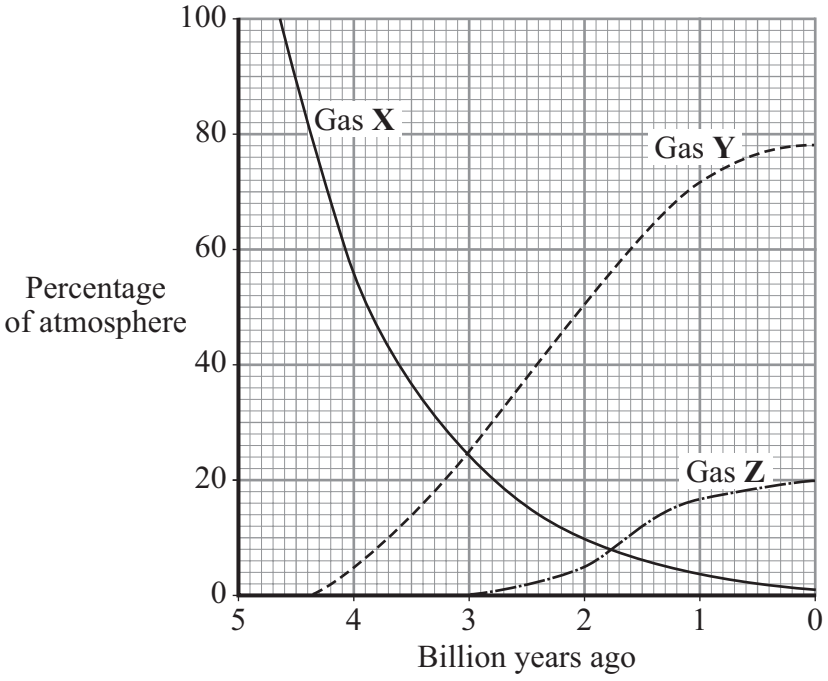
Question 10

June 2009 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Gases **X**, **Y** and **Z** are found in the Earth's atmosphere today.

The graph shows how the percentages of these gases in the atmosphere have changed over the last five billion years.



8A Which row in the table correctly describes the gases **X**, **Y** and **Z**?

	Gas X	Gas Y	Gas Z
1	Carbon dioxide	Nitrogen	Oxygen
2	Oxygen	Nitrogen	Carbon dioxide
3	Nitrogen	Carbon dioxide	Oxygen
4	Carbon dioxide	Oxygen	Nitrogen

4.9.1.1 The proportions of different gases in the atmosphere

Question 10 · continued June 2009 | CHY1BP | Original Q8 | Legacy

8B The Earth's atmosphere today contains the noble gas argon, which is by far the most abundant noble gas.

Argon is used in filament light bulbs because . . .

1 it has a low density.

2 it glows red when hot.

3 it can be obtained from the air by filtration.

4 it is chemically unreactive.

The table below shows the amounts of carbon dioxide in the Earth's atmosphere since 1750.

Year	1750	1800	1850	1900	1950	2000
Percentage (%) of carbon dioxide by volume	0.0270	0.0282	0.0288	0.0297	0.0310	0.0368

8C A graph of percentage (%) of carbon dioxide on the *y*-axis against time on the *x*-axis from 1750 to 2000 would show . . .

1 direct proportionality after 1800.

2 many anomalous values.

3 random scatter.

4 stronger positive correlation after 1850 than before.

8D The values given in the table show . . .

1 sensitivity because the values are close together.

2 reliability because the values are calculated by modern techniques.

3 precision because the values are given to 4 decimal places.

4 accuracy because famous scientists have calculated the values.

4.9.1.1 The proportions of different gases in the atmosphere

Question 11

June 2009 | CHY1H | Original Q3 | Legacy

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

3 (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.

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

.....

.....

(1 mark)

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

Temperature = ... °C

(1 mark)

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

.....

.....

.....

.....

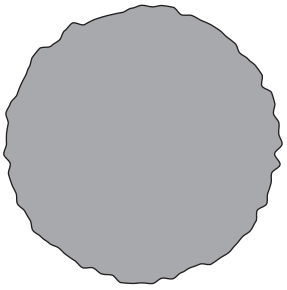
(2 marks)

4.9.1.1 The proportions of different gases in the atmosphere

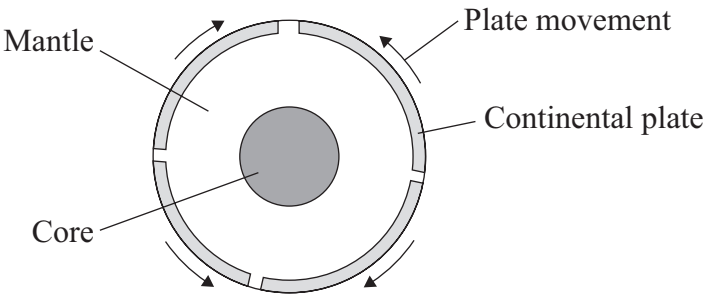
Question 11 · continued

for mark

3 (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.



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

.....

.....

(1 mark)

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

.....

.....

.....

.....

.....

.....

(3 marks)

8

4.9.1.1 The proportions of different gases in the atmosphere

Question 12

November 2009 | CHY1BP | Original Q9 | Legacy

QUESTION NINE

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

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

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

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

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

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

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

1 there is too much evidence available.

2 the information can be interpreted in different ways.

3 the data is inaccurate.

4 geological records do not go back far enough.

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

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

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

3 The atmosphere now contains more than 20% oxygen.

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

4.9.1.1 The proportions of different gases in the atmosphere

Question 12 · continued

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

1 Some carbon dioxide has dissolved in the oceans.

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

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

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

9D Which one of the following statements is true?

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

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

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

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

END OF TEST

4.9.1.1 The proportions of different gases in the atmosphere

Question 13

March 2010 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

All the gases in the Earth's atmosphere can be separated by this method:

- remove the carbon dioxide
- cool the air down to a very low temperature so that it liquefies
- allow the liquefied gases to warm up
- collect the gases as they boil off at different temperatures.

The table below gives some information about the gases in the Earth's atmosphere.

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

8A In this method of separation, carbon dioxide is always removed from the air before it is liquefied because . . .

1 it would react with the other gases present.

2 it would solidify during cooling and block up the pipes.

3 it is a greenhouse gas and would warm up the apparatus.

4 it is a heavy gas and would not separate properly from the mixture.

4.9.1.1 The proportions of different gases in the atmosphere

Question 13 · continued March 2010 | CHY1BP | Original Q8 | Legacy

8B How many of the gases listed in the table (excluding carbon dioxide), would be liquid at –150 °C?

1 None

2 1

3 2

4 3

8C Argon is the cheapest of the noble gases to produce because . . .

1 there is high demand for it for use in light bulbs.

2 it is the most abundant of the noble gases.

3 it is the gas that vaporises most easily and so requires the least energy to remove it.

4 it is an unreactive gas so it can easily be separated from the other gases in the air.

8D Earth's early atmosphere contained a high percentage (%) of carbon dioxide.

One reason for the reduction of the percentage of carbon dioxide is that carbon dioxide . . .

1 has dissolved in the oceans.

2 has been reduced to carbon monoxide.

3 has decomposed to form carbon and oxygen.

4 has been released by plants.

4.9.1.1 The proportions of different gases in the atmosphere

Question 14

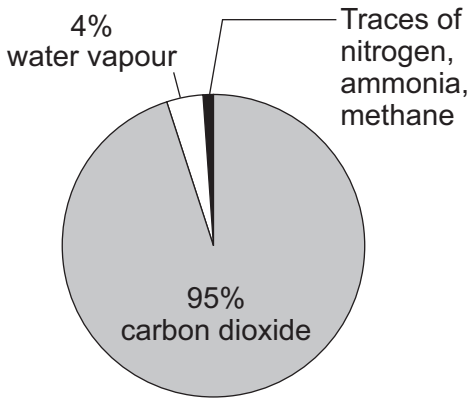
June 2010 | CHY1H | Original Q2 | Legacy

2 (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.

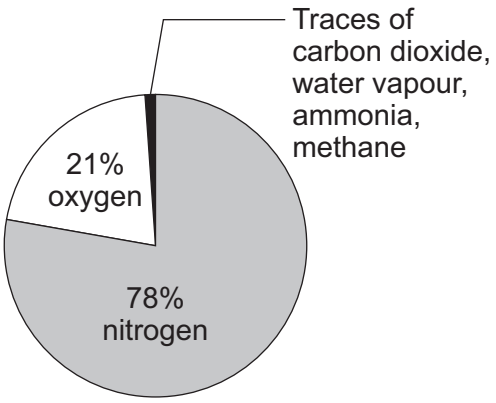
The pie charts show the approximate percentages of gases in the Earth's early atmosphere and in the Earth's atmosphere today.

Earth's early atmosphere



Average surface temperature above 400 °C

Earth's atmosphere today



Average surface temperature 20 °C

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

.....

.....

.....

.....

(2 marks)

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

1 .....

.....

2 .....

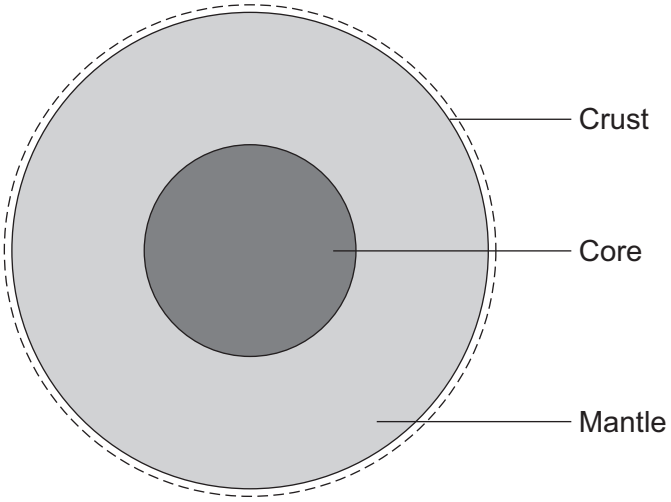
.....

(2 marks)

4.9.1.1 The proportions of different gases in the atmosphere

Question 14 · continued

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.

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

.....

.....

(1 mark)

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

.....

.....

.....

.....

.....

.....

(3 marks)

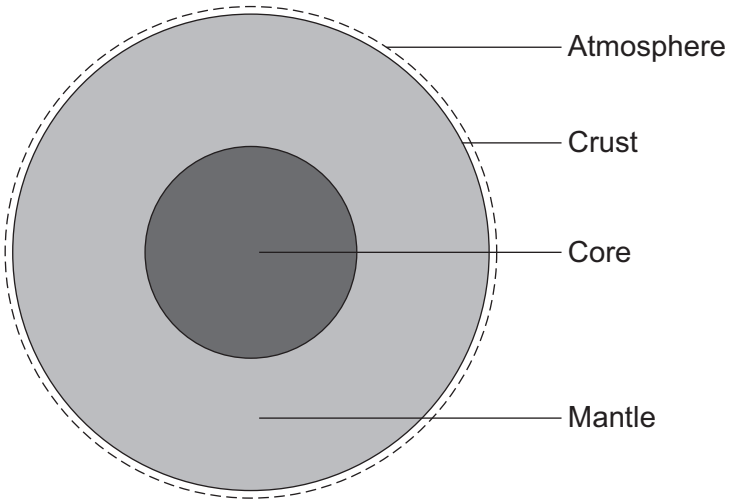
8

4.9.1.1 The proportions of different gases in the atmosphere

Question 15

January 2011 | CHY1H | Original Q3 | Legacy

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



3 (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.

3 (a) (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 marks)

3 (a) (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.

.....

.....

.....

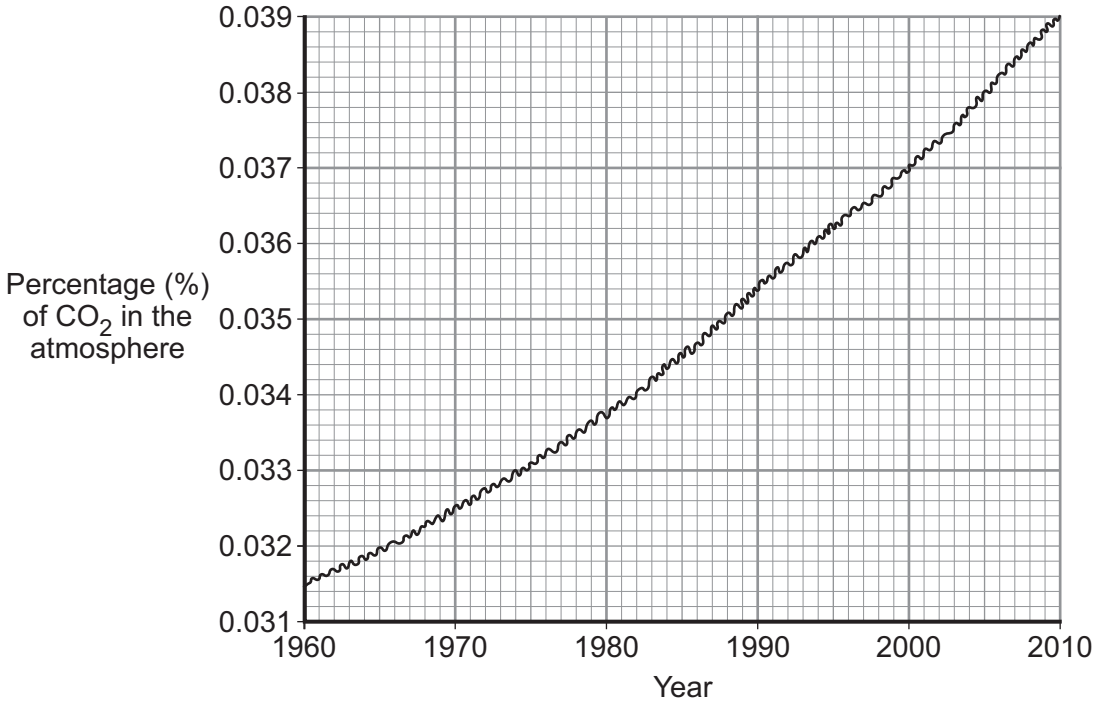
.....

(2 marks)

4.9.1.1 The proportions of different gases in the atmosphere

Question 15 · continued

3 (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.

.....

.....

.....

.....

.....

.....

.....

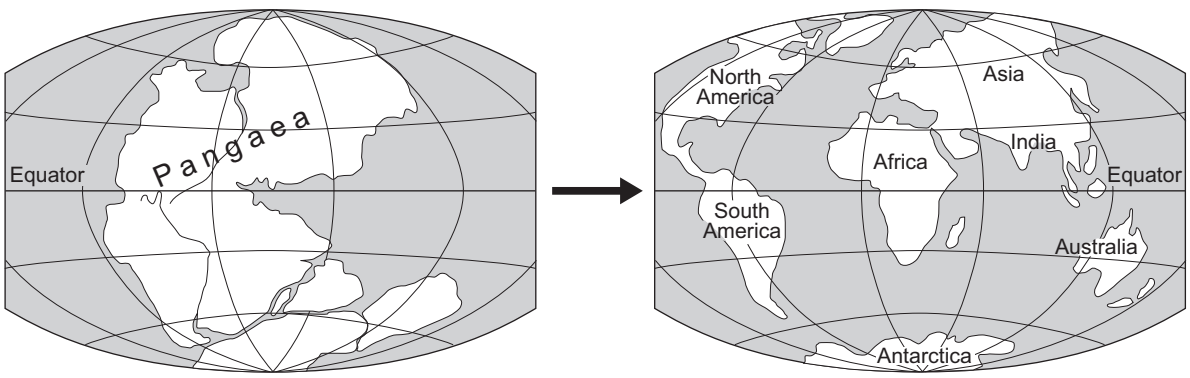
(3 marks)

Question 3 continues on the next page

4.9.1.1 The proportions of different gases in the atmosphere

Question 15 · continued

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.

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

.....

.....

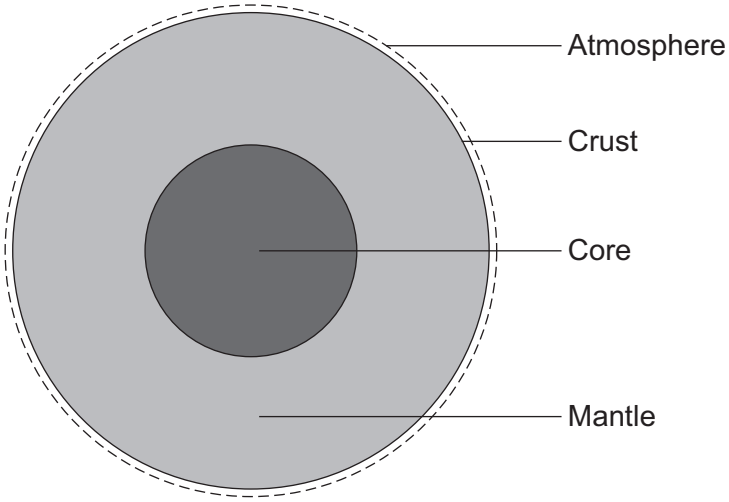
(1 mark)

4.9.1.1 The proportions of different gases in the atmosphere

Question 15 · continued

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

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



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

.....

.....

.....

.....

.....

.....

(3 marks)

11

4.9.1.1 The proportions of different gases in the atmosphere

Question 16

June 2011 | CHY1BP | Original Q9 | Legacy

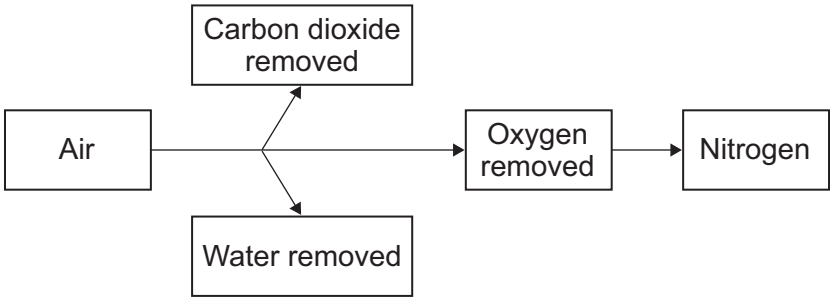
QUESTION NINE

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

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

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

Lord Rayleigh extracted nitrogen from the air.



He also collected very pure nitrogen by heating ammonium nitrate.

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

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

4.9.1.1 The proportions of different gases in the atmosphere

Question 16 · continued June 2011 | CHY1BP | Original Q9 | Legacy

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

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

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

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

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

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

This was because these other gases . . .

1 are colourless.

2 have a very low density.

3 are unreactive.

4 have very low boiling points.

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

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

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

1 It is present only in very small quantities.

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

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

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

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

1 argon, nitrogen, oxygen

2 oxygen, nitrogen, argon

3 nitrogen, argon, oxygen

4 argon, oxygen, nitrogen

END OF TEST

4.9.1.1 The proportions of different gases in the atmosphere

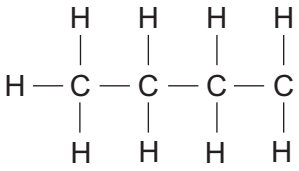
Question 17

June 2011 | CHY1H | Original Q5 | Legacy

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

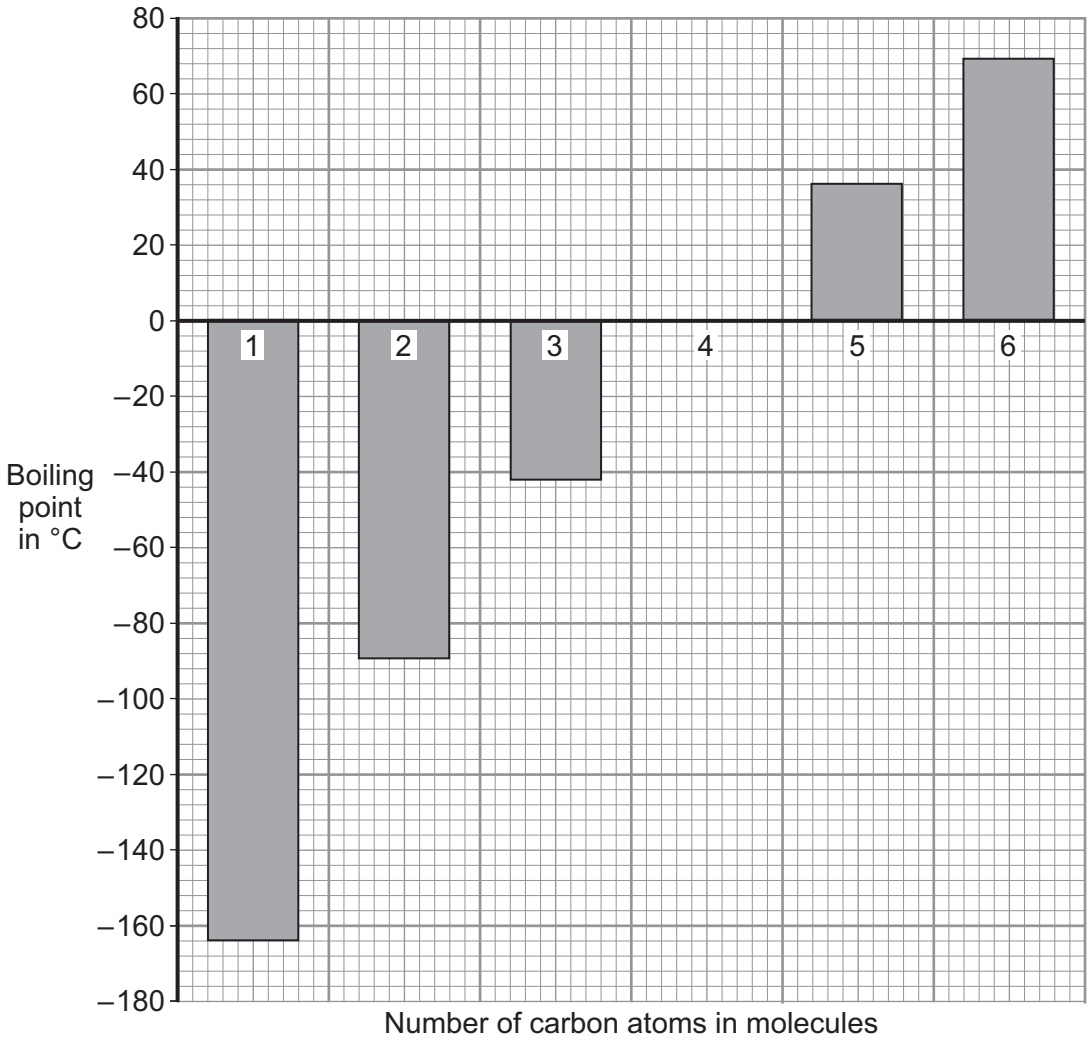
5 (a) The general formula of an alkane is C_nH_{2n+2}

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



(1 mark)

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



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

.....

.....

(1 mark)

4.9.1.1 The proportions of different gases in the atmosphere

Question 17 · continued June 2011 | CHY1H | Original Q5 | Legacy

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

1 .....

.....

2 .....

.....

(2 marks)

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

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

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

(1 mark)

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

.....

.....

(1 mark)

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

.....

.....

.....

.....

.....

.....

(2 marks)

8

4.9.1.1 The proportions of different gases in the atmosphere

Question 18

November 2011 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

The table shows the abundance in the Earth's atmosphere of each of four noble gases.

Noble gas	Abundance (percentage in the atmosphere by volume)
Argon	0.9300
Neon	0.0018
Helium	0.0005
Krypton	0.0001

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

A abundance

B colour

C density

D reactivity

Argon is used in filament lamps because of its low chemical . . . **1** . . . .

Neon is used in electric discharge tubes for advertising signs because it produces a bright . . . **2** . . . .

Helium is used in balloons because it has a low . . . **3** . . . .

Krypton is the noble gas in the table with the lowest . . . **4** . . . .

4.9.1.1 The proportions of different gases in the atmosphere

Question 19

November 2011 | CHY1BP | Original Q6 | Legacy

QUESTION SIX

The atmosphere is made up of many different gases.

The abundance, melting points, and the boiling points of the noble gases are given in the table.

Noble gas	Abundance (percentage in the atmosphere by volume)	Melting point in °C	Boiling point in °C
Helium	0.0005	–272	–269
Neon	0.0018	–248	–229
Argon	0.93	–189	–186
Krypton	0.0001	–157	–153
Xenon	0.000009	–112	–108

6A Which of the following statements about the gases in the atmosphere is correct?

1 There is about 10 times as much argon as krypton.

2 There is about 20 times as much oxygen as argon.

3 There is about 4 times as much oxygen as nitrogen.

4 There is about 5 times as much nitrogen as oxygen.

6B Which noble gas is liquid over the largest temperature range?

1 neon

2 krypton

3 helium

4 argon

4.9.1.1 The proportions of different gases in the atmosphere

Question 19 · continued

6C Which row in the table below correctly describes the properties of the noble gases?

	Melting point/boiling point	Use	Position in the periodic table
1	Melting point above room temperature (20 °C)	Provides a reactive atmosphere	In group 0
2	Melting point below room temperature (20 °C)	Provides an unreactive atmosphere	In group 7
3	Boiling point below room temperature	Provides a reactive atmosphere	In group 1
4	Boiling point is higher than the melting point	Provides an unreactive atmosphere	In group 0

6D The average concentration of carbon dioxide in the atmosphere is about 390 parts per million (0.039 %).

Which row in the table below shows the best way to measure this amount?

	Instrument reading to . . .	How readings are taken and used
1	10 parts per million	In several locations in a small area and take an average
2	2 parts per million	Average the highest and lowest values obtained
3	10 parts per million	Take values from industrialised areas and take an average
4	2 parts per million	Average the values taken over a large number of randomly selected locations

4.9.1.1 The proportions of different gases in the atmosphere

Question 20

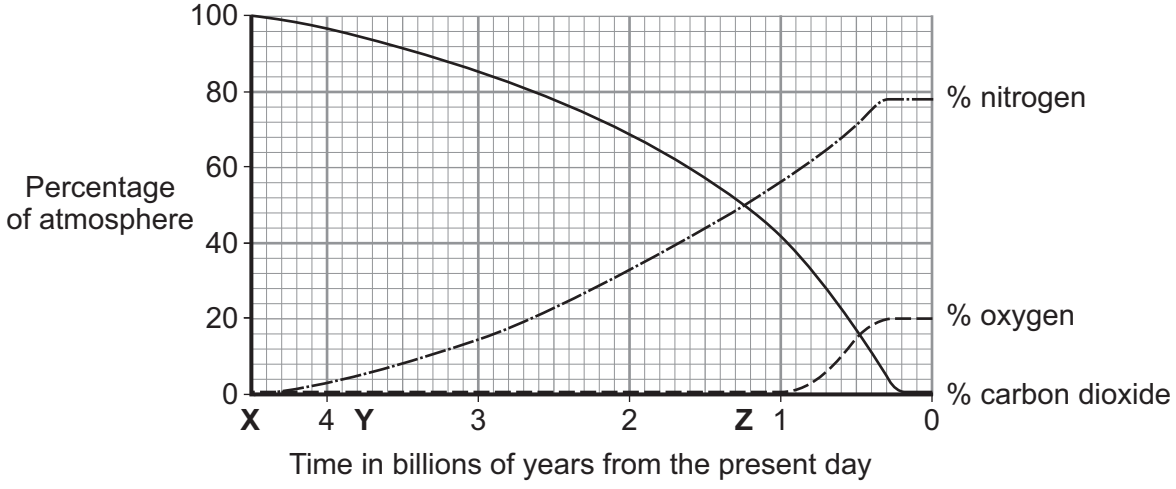
November 2011 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

This question is about changes in the Earth's atmosphere that have occurred over time.

The Earth's early atmosphere was mainly carbon dioxide with small amounts of methane and ammonia.

The graph shows how the percentages of carbon dioxide, nitrogen and oxygen may have changed over time.



7A About how many years after the Earth was formed (**X**) did the percentage of carbon dioxide in the atmosphere fall to 60 %?

1 1.3 billion years

2 1.6 billion years

3 2.4 billion years

4 2.9 billion years

7B At a particular stage in the Earth's formation, some of the iron on its surface was oxidised.

What gas in the atmosphere could **not** have caused this change?

1 nitrogen

2 carbon dioxide

3 oxygen

4 water vapour

4.9.1.1 The proportions of different gases in the atmosphere

Question 20 · continued

7C Between times **Y** and **Z**, the amount of carbon dioxide in the atmosphere was reduced.

Which of the following statements could explain this reduction?

Most of the carbon dioxide . . .

1 dissolved in the oceans.

2 was absorbed by plants.

3 was absorbed to form carbonate rocks in the mantle.

4 became locked up in coal, oil and natural gas.

7D The graph showing the percentages of the various gases has . . .

1 categoric variables plotted against a discrete variable.

2 discrete variables plotted against a continuous variable.

3 continuous variables plotted against a continuous variable.

4 continuous variables plotted against a discrete variable.

4.9.1.1 The proportions of different gases in the atmosphere

Question 21

January 2012 | CH1HP | Original Q2 | Legacy

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

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

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

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

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

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

.....

(1 mark)

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

$$C_nH$$

(1 mark)

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

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

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

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

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

.....

(1 mark)

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

.....

.....

(1 mark)

Question 2 continues on the next page

4.9.1.1 The proportions of different gases in the atmosphere

Question 21 · continued

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

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

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

.....

(1 mark)

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

.....

(1 mark)

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

.....

.....

(1 mark)

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

.....

.....

.....

.....

(2 marks)

4.9.1.1 The proportions of different gases in the atmosphere

Question 21 · continued

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

Explain why.

.....

.....

.....

.....

(2 marks)

11

Turn over for the next question

4.9.1.1 The proportions of different gases in the atmosphere

Question 22

June 2012 | CH1HP | Original Q4 | Legacy

4 Venus is often compared to the Earth. The Earth's early atmosphere was mainly carbon dioxide like the atmosphere of Venus today.

Atmosphere of Earth today		Atmosphere of Venus today	
Gas	**Percentage (%)**	**Gas**	**Percentage (%)**
Nitrogen	78	Nitrogen	3.5
Oxygen	21	Oxygen	A trace
Carbon dioxide	0.04	Carbon dioxide	96

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

.....

.....

.....

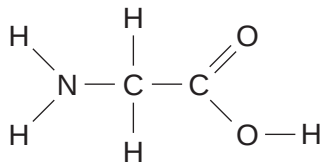
.....

(2 marks)

4 (b) In the 1950s two scientists, Miller and Urey, investigated the origin of life on Earth.
Miller and Urey used the gases that they believed were in the Earth's early atmosphere and used water to represent the oceans.
The gases they used were methane (CH_4), ammonia (NH_3) and hydrogen (H_2).
A continuous electrical spark was used to simulate lightning storms.

After one week the Miller-Urey experiment had produced amino acids.
Amino acids are essential to life.

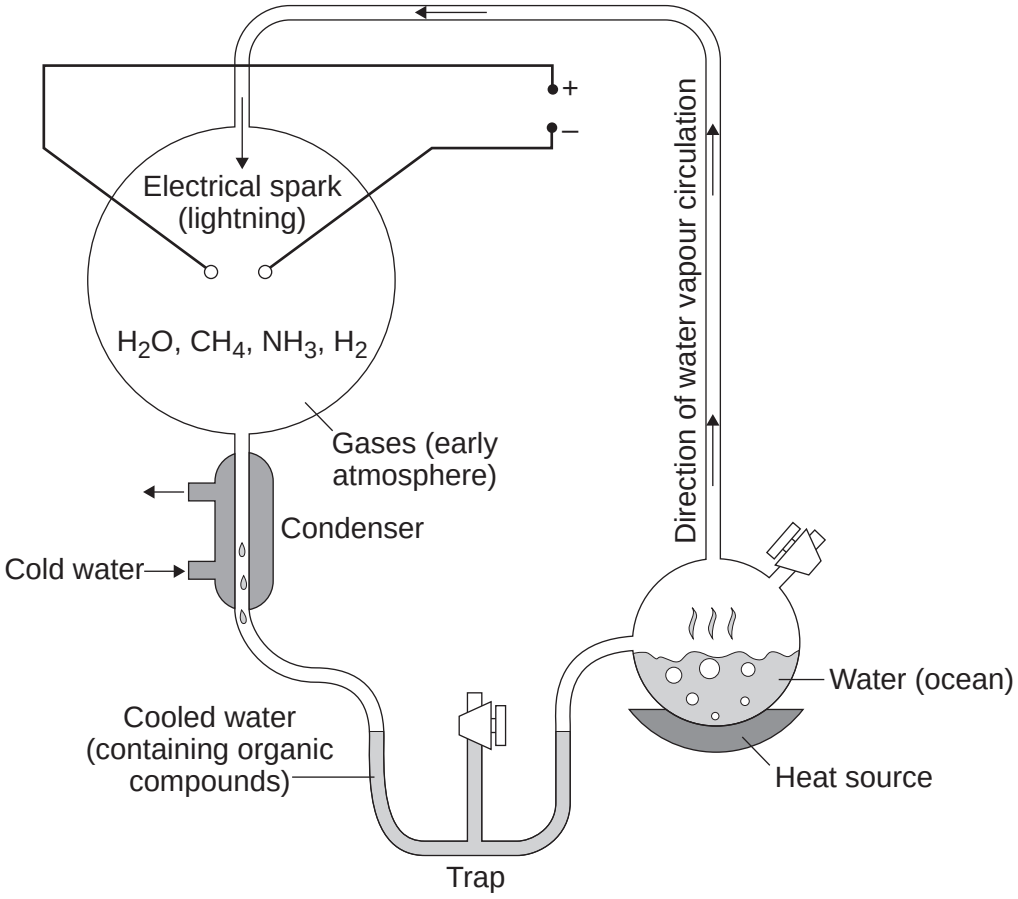
The simplest amino acid is glycine (aminoethanoic acid).



4.9.1.1 The proportions of different gases in the atmosphere

Question 22 · continued

The apparatus used in the Miller-Urey experiment is shown in the diagram.



Use the information in the diagram and on page 10 to answer these questions.

4 (b) (i) Miller and Urey used methane, ammonia and hydrogen for the Earth's early atmosphere.

Suggest why.

.....

.....

(1 mark)

4 (b) (ii) The experiment provides only weak evidence of how amino acids formed on Earth.

Suggest **two** reasons why.

.....

.....

.....

.....

(2 marks)

5

4.9.1.1 The proportions of different gases in the atmosphere

Question 23

June 2012 | CH1HP | Original Q8 | Legacy

8 The table shows some properties of gases in dry air.

Gas in dry air	Density in kg/m^3	Melting point in °C	Boiling point in °C	Percentage (%) in air
Nitrogen	1.2506	–210	–196	78.08
Oxygen	1.4290	–219	–183	20.95
Carbon dioxide	1.977	–57	–57	0.033
Helium	0.1785	–272	–269	0.00052
Neon	0.8999	–249	–246	0.0019
Argon	1.7837	–189	–186	0.934
Krypton	3.74	–157	–153	0.00011
Xenon	5.86	–112	–108	0.0000087

8 (a) In 1895, Lord Rayleigh isolated nitrogen from dry air by removing the other known gases, oxygen and carbon dioxide.
He then discovered that nitrogen from dry air had a different density to pure nitrogen produced from chemical reactions.
He concluded that nitrogen extracted from dry air was mixed with another gas.
The density of nitrogen extracted from dry air was higher than the density of pure nitrogen.

Use the information above to explain why.

.....

.....

.....

.....

(2 marks)

4.9.1.1 The proportions of different gases in the atmosphere

Question 23 · continued

8 (b) Gases from the air are separated to provide raw materials used in many different industrial processes.

Steps in dry air separation:

Step 1: Filter to remove solid particles

Step 2: Remove carbon dioxide

Step 3: Cool the remaining air to –200 °C

Step 4: Separate by allowing the liquefied gases to warm up.

8 (b) (i) Carbon dioxide is removed before the air is cooled to –200 °C.

Suggest **one** reason why.

.....

.....

(1 mark)

8 (b) (ii) Which two gases do **not** condense when the remaining air is cooled to –200 °C?

..... and .....

(1 mark)

8 (b) (iii) Two gases in air do **not** separate completely when the liquefied gases are allowed to warm up.

Name these **two** gases and give a reason for your answer.

.....

.....

.....

.....

(2 marks)

6

4.9.1.1 The proportions of different gases in the atmosphere

Question 24

June 2013 | CH1HP | Original Q5 | Legacy

5 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.

5 (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.

5 (a) (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 marks)

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

What is *locked up* carbon dioxide?

.....

.....

.....

.....

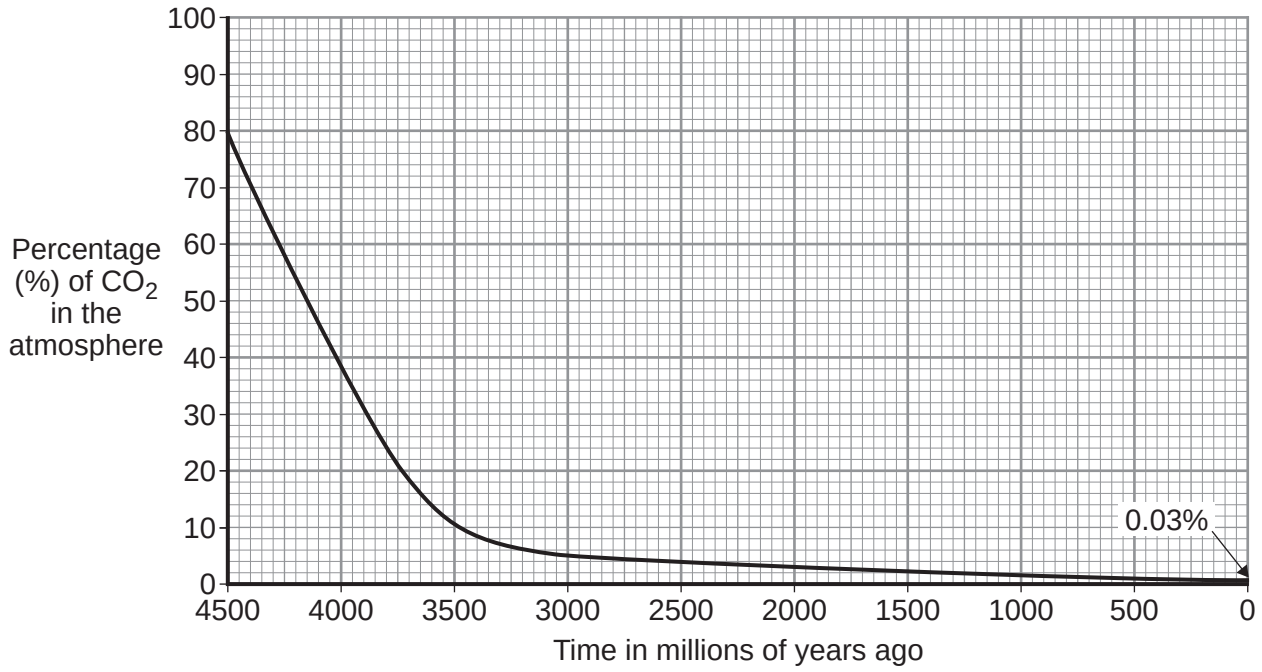
(2 marks)

4.9.1.1 The proportions of different gases in the atmosphere

Question 24 · continued

5 (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.

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

.....

.....

.....

.....

(2 marks)

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

.....

.....

.....

.....

(2 marks)

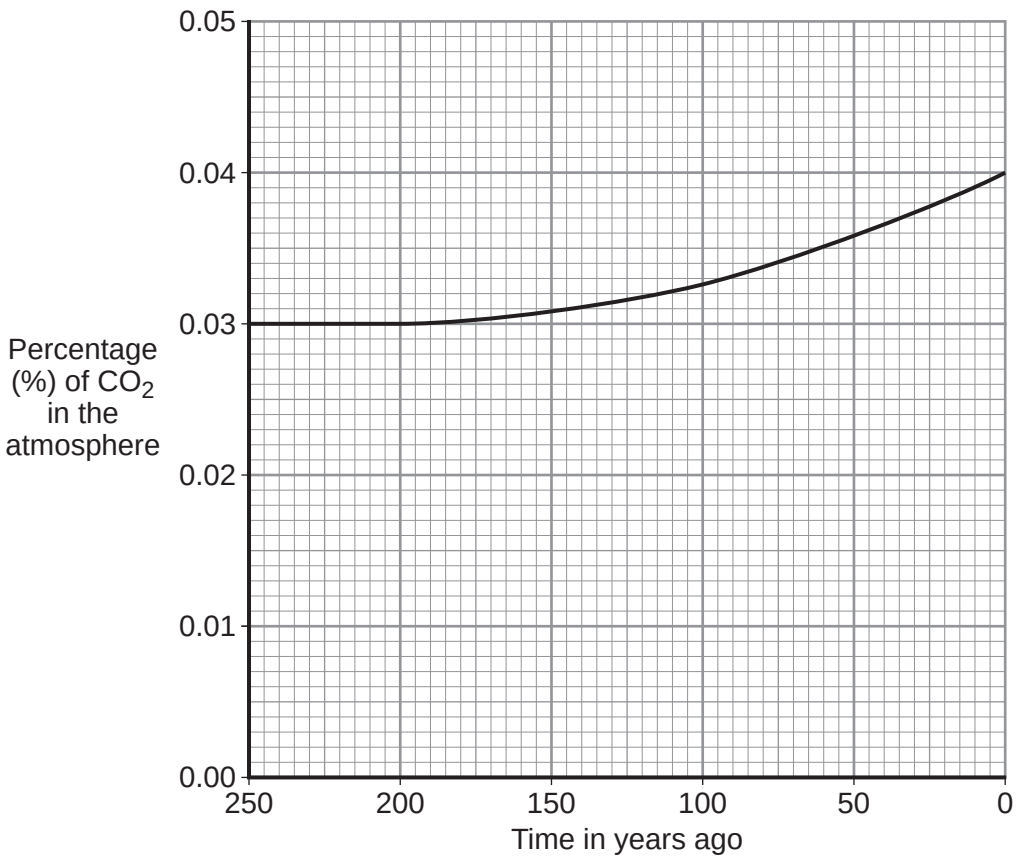
Question 5 continues on the next page

4.9.1.1 The proportions of different gases in the atmosphere

Question 24 · continued

5 (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.

.....

.....

.....

.....

(2 marks)

10

4.9.1.1 The proportions of different gases in the atmosphere

Question 25

June 2014 | CH3HP | Original Q5 | Legacy

5 In 1909 Fritz Haber invented a process to produce ammonia from nitrogen and hydrogen.

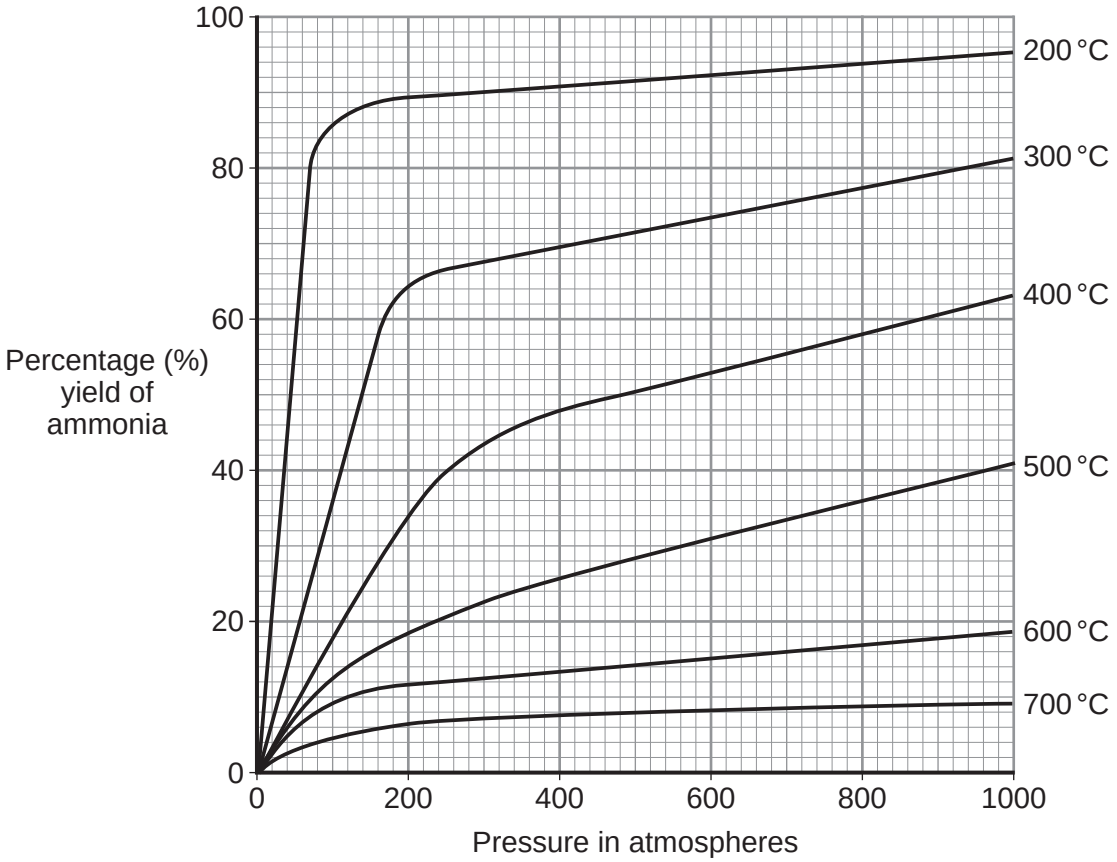
5 (a) Complete and balance the chemical equation for the production of ammonia from nitrogen and hydrogen.

[2 marks]

$$N_2 \quad + \quad 3H_2 \quad \rightleftharpoons \quad .....$$

5 (b) **Figure 5** shows how the equilibrium yield of ammonia changes with pressure at different temperatures.

Figure 5



5 (b) (i) Use the information in **Figure 5** to complete the sentence.

[1 mark]

The temperature on the graph that gives the highest yield of ammonia is ..... °C.

5 (b) (ii) The temperature used in the Haber process for the production of ammonia is 450 °C.

Why is a temperature much lower than 450 °C **not** used for the Haber process?

[1 mark]

.....

.....

4.9.1.1 The proportions of different gases in the atmosphere

Question 25 · continued

5 (b) (iii) Use the information in **Figure 5** to answer this question.

Draw a ring around the pressure that gives the highest yield of ammonia.

[1 mark]

100 **200** **300** **400**

5 (b) (iv) The pressure used in the Haber process for the production of ammonia is 200 atmospheres.

Why is a pressure lower than 200 atmospheres **not** used for the Haber process?

[1 mark]

.....

.....

5 (c) Explain how ammonia is separated from unreacted nitrogen and hydrogen in the Haber process.

[2 marks]

.....

.....

.....

.....

8

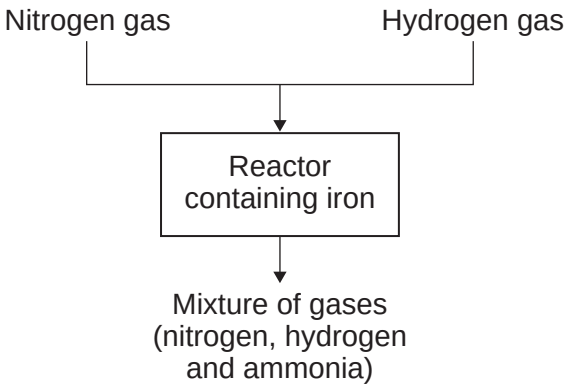
4.9.1.1 The proportions of different gases in the atmosphere

Question 26

June 2016 | CH3HP | Original Q6 | Legacy

6 **Figure 6** shows a flow diagram for the Haber process.

Figure 6



6 (a) (i) Hydrogen gas is obtained from methane.
Name **one** source of methane.

[1 mark]

_____

6 (a) (ii) Air is the source used to produce nitrogen for the Haber process.
Suggest why air must **not** get into the reactor.

[2 marks]

_____

_____

_____

6 (a) (iii) Describe what happens to the mixture of gases from the reactor.

[3 marks]

_____

_____

_____

_____

_____

_____

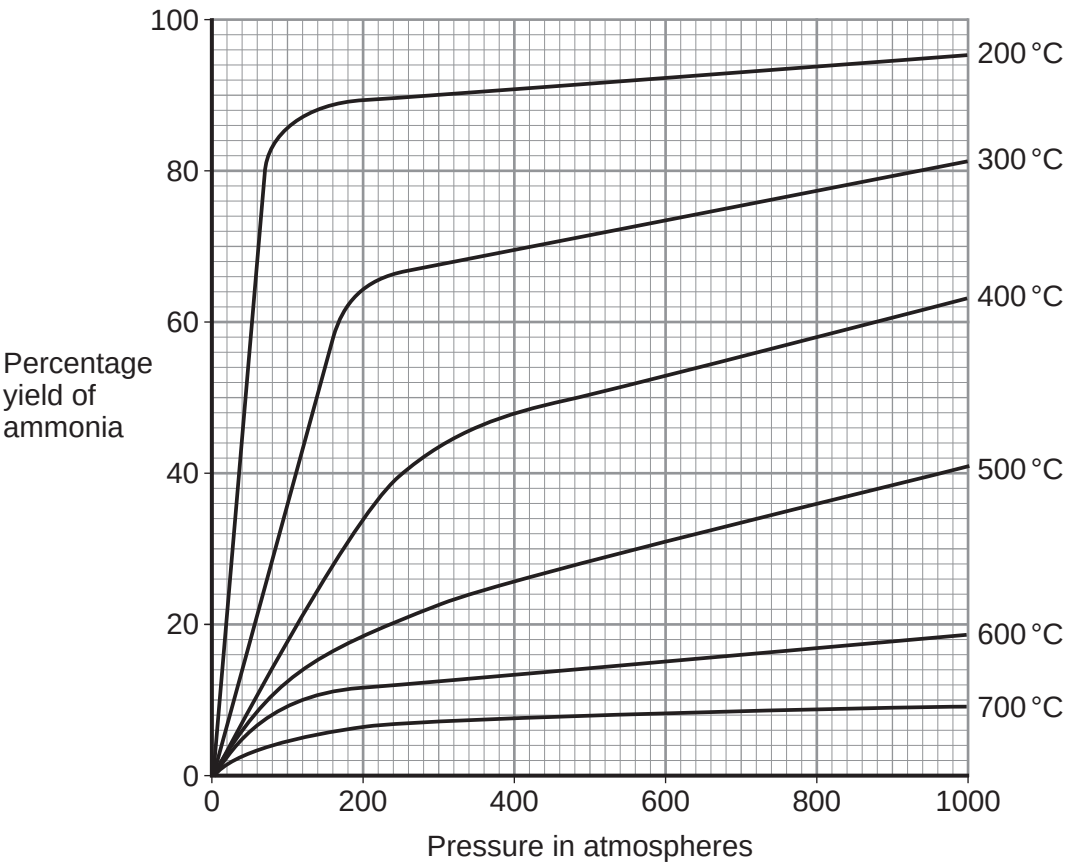
Question 6 continues on the next page

4.9.1.1 The proportions of different gases in the atmosphere

Question 26 · continued

6 (b) The graph in **Figure 7** shows the percentage yield of ammonia using different conditions.

Figure 7



6 (b) (i) Use **Figure 7** to suggest the conditions that produce the greatest yield of ammonia.

[1 mark]

4.9.1.1 The proportions of different gases in the atmosphere

Question 26 · continued

6 (b) (ii) Use **Figure 7** to suggest and explain why the conditions used to produce ammonia in the Haber process are a temperature of 450 °C and a pressure of 200 atmospheres.

[5 marks]

12

4.9.1.1 The proportions of different gases in the atmosphere

Question 27

June 2017 | CH1HP | Original Q5 | Legacy

5 This question is about the Earth's atmosphere.

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

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

Table 4

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

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

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

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

[1 mark]

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

[3 marks]

4.9.1.1 The proportions of different gases in the atmosphere

Question 27 · continued

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

Table 5

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

*freezes at this temperature

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

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

[1 mark]

_____ and _____

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

[1 mark]

_____

_____

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

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

[2 marks]

_____

_____

_____

_____

4.9.1.1 The proportions of different gases in the atmosphere

Question 27 · continued

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

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

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

Stage 1 pass oxygen into molten cast iron

Stage 2 add small amounts of other metals.

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

[4 marks]

12

4.9.1.1 The proportions of different gases in the atmosphere

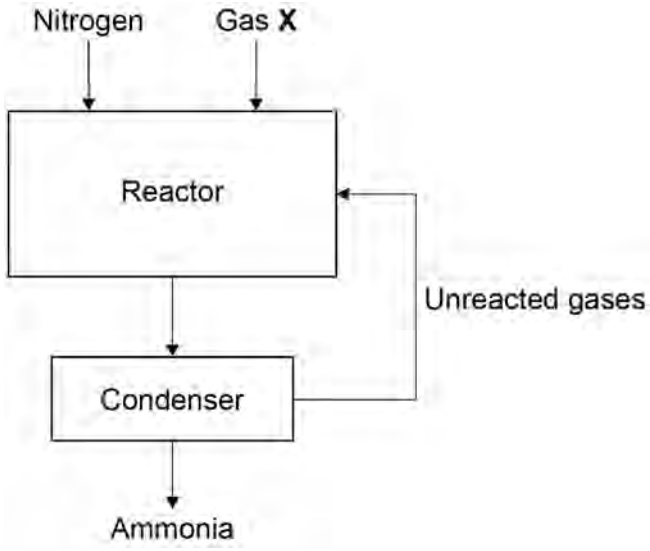
Question 28

June 2018 | 8462/2H | Original Q3

0 3 This question is about gases.

Figure 3 shows how nitrogen is used in the Haber Process to produce ammonia.

Figure 3



0 3 . 1 Gas **X** in **Figure 3** is obtained from methane.

Name gas **X**.

[1 mark]

_____

0 3 . 2 Give the approximate temperature and pressure used in the reactor.

[2 marks]

Temperature _____

Pressure _____

0 3 . 3 The mixture of gases from the reactor cools in the condenser.

Suggest why ammonia condenses but the other gases do not.

[1 mark]

_____

_____

4.9.1.1 The proportions of different gases in the atmosphere

Question 28 · continued

The Earth's early atmosphere was different to Earth's atmosphere today.

Scientists think that the Earth's early atmosphere was like the atmosphere found on Venus today.

Table 2 shows the amounts of carbon dioxide and oxygen in the atmospheres of Venus and Earth today.

Table 2

Gas	Percentage (%) in Venus' atmosphere today	Percentage (%) in Earth's atmosphere today
Carbon dioxide	96.50	0.04
Oxygen	0.00	20.95

0 3 . 4 The percentages of carbon dioxide and oxygen have changed from Earth's early atmosphere to Earth's atmosphere today.

Explain the processes that led to these changes.

[6 marks]

4.9.1.1 The proportions of different gases in the atmosphere

Question 28 · continued

0 3 . 5 Why are scientists **not** certain about the percentage of each gas in the Earth's early atmosphere?

[1 mark]

11

Turn over for the next question

4.9.1.1 The proportions of different gases in the atmosphere

Question 29

June 2019 | 8462/2H | Original Q8

0 8 Titan is a moon of the planet Saturn.

Table 3 shows the percentages of the gases in the atmosphere of Titan.

Table 3

Gas	Percentage of gas in atmosphere (%)
Nitrogen	98.4
Methane	1.4
Other gases	0.2

0 8 . 1 Some scientists think that living organisms could have evolved on Titan.

Explain why these organisms could **not** have evolved in the same way that life is thought to have evolved on Earth.

Use **Table 3**.

[3 marks]

4.9.1.1 The proportions of different gases in the atmosphere

Question 29 · continued

0 8 . 2 Saturn has other moons.

The other moons of Saturn have no atmosphere.

Titan is warmer than the other moons of Saturn because its atmosphere contains the greenhouse gas methane.

Explain how this greenhouse gas keeps Titan warmer than the other moons of Saturn.

[3 marks]

0 8 . 3 The atmosphere of Titan contains small amounts of propene.

Describe a test to show that propene is an unsaturated hydrocarbon.

Give the result of the test.

[2 marks]

Test

Result

8

4.9.1.1 The proportions of different gases in the atmosphere

Question 30

June 2019 | 8462/2H | Original Q10

1 0 This question is about reversible reactions and equilibrium.

Hydrogen is used to produce ammonia in the Haber process.

The hydrogen is made in two stages.

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

The equation for the reaction is:

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

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

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

[2 marks]

Atom economy = _____ %

4.9.1.1 The proportions of different gases in the atmosphere

Question 30 · continued

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

Give your answer in terms of equilibrium.

[2 marks]

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

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

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

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

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

[1 mark]

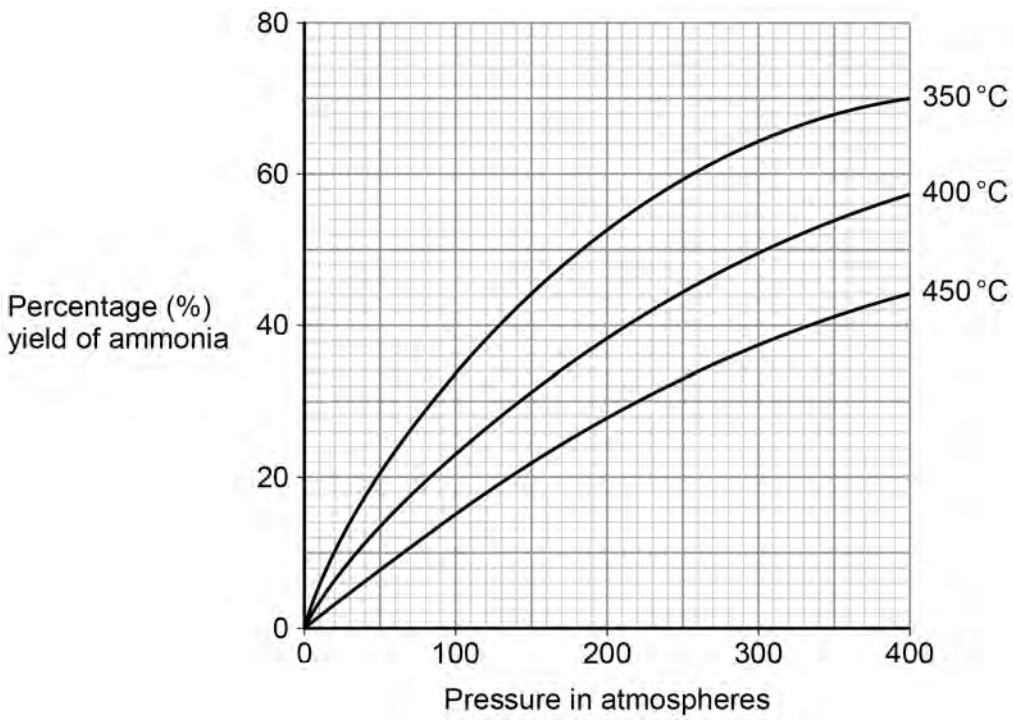
Question 10 continues on the next page

4.9.1.1 The proportions of different gases in the atmosphere

Question 30 · continued

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

Figure 10



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

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

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

Use **Figure 10**.

[3 marks]

Percentage yield = _____ times greater

4.9.1.1 The proportions of different gases in the atmosphere

Question 30 · continued

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

Give **one** reason why.

[1 mark]

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

[1 mark]

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

Suggest why the demand for ammonia has increased.

[2 marks]

12

4.9.1.1 The proportions of different gases in the atmosphere

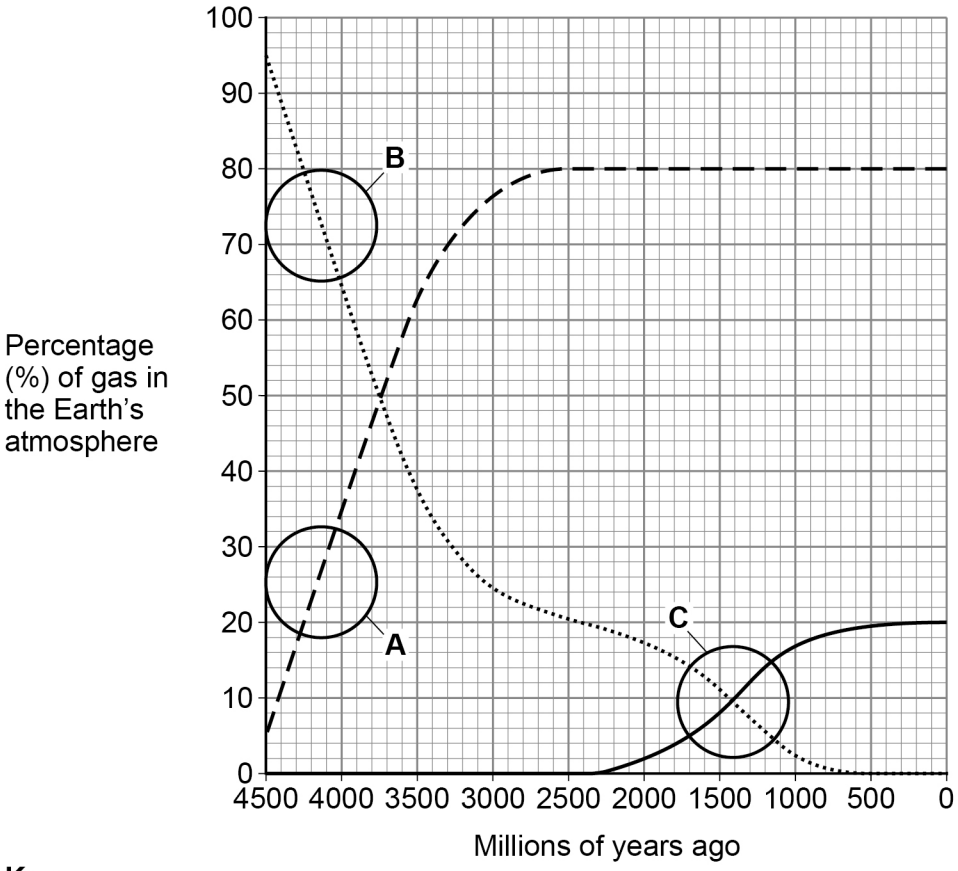
Question 31

June 2022 | 8462/2H | Original Q6

0 6 This question is about the chemistry of the Earth's atmosphere.

Figure 3 shows how the percentages of gases in the Earth's atmosphere may have changed since the atmosphere was formed.

Figure 3



0 6 . 1 Explain the change in the percentage of gas in the region labelled **A** on **Figure 3**.

[2 marks]

4.9.1.1 The proportions of different gases in the atmosphere

Question 31 · continued

0 6 . 2 Explain the change in the percentage of gas in the region labelled **B** on **Figure 3**.

[2 marks]

0 6 . 3 Compare the changes in the percentages of gases in the region labelled **C** on **Figure 3**.

[2 marks]

0 6 . 4 What process caused the changes in the percentages of gases in the region labelled **C** on **Figure 3**?

[1 mark]

0 6 . 5 Natural gas is a fossil fuel.

Describe how deposits of natural gas were formed.

[3 marks]

10

4.9.1.1 The proportions of different gases in the atmosphere

Question 32

June 2022 | 8462/2H | Original Q7

0 7 Ammonia is produced in the Haber process.

The raw materials for the Haber process are nitrogen and hydrogen.

The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

0 7 . 1 Give the sources of the nitrogen and of the hydrogen used in the Haber process.

[2 marks]

Nitrogen _____

Hydrogen _____

0 7 . 2 How does the equation for the reaction show that the atom economy of the forward reaction is 100%?

[1 mark]

_____

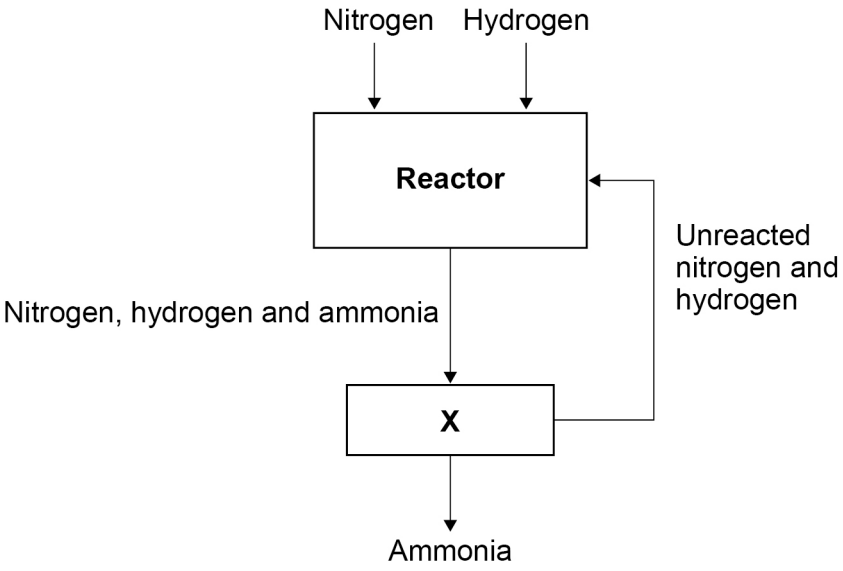
_____

4.9.1.1 The proportions of different gases in the atmosphere

Question 32 · continued

0 7 . 3 **Figure 4** represents the Haber process.

Figure 4



Explain how the ammonia produced is separated from the unreacted nitrogen and hydrogen in **X**.

[2 marks]

Question 7 continues on the next page

4.9.1.1 The proportions of different gases in the atmosphere

Question 32 · continued

The Haber process uses a temperature of 450 °C and a pressure of 200 atmospheres.

Table 6 shows the percentage yield of ammonia produced at 450 °C using different pressures.

Table 6

Pressure in atmospheres	Percentage (%) yield of ammonia
60	9
120	18
180	25
240	31
300	36
360	40
420	43

4.9.1.1 The proportions of different gases in the atmosphere

Question 32 · continued

0 7 . 4 Complete **Figure 5**.

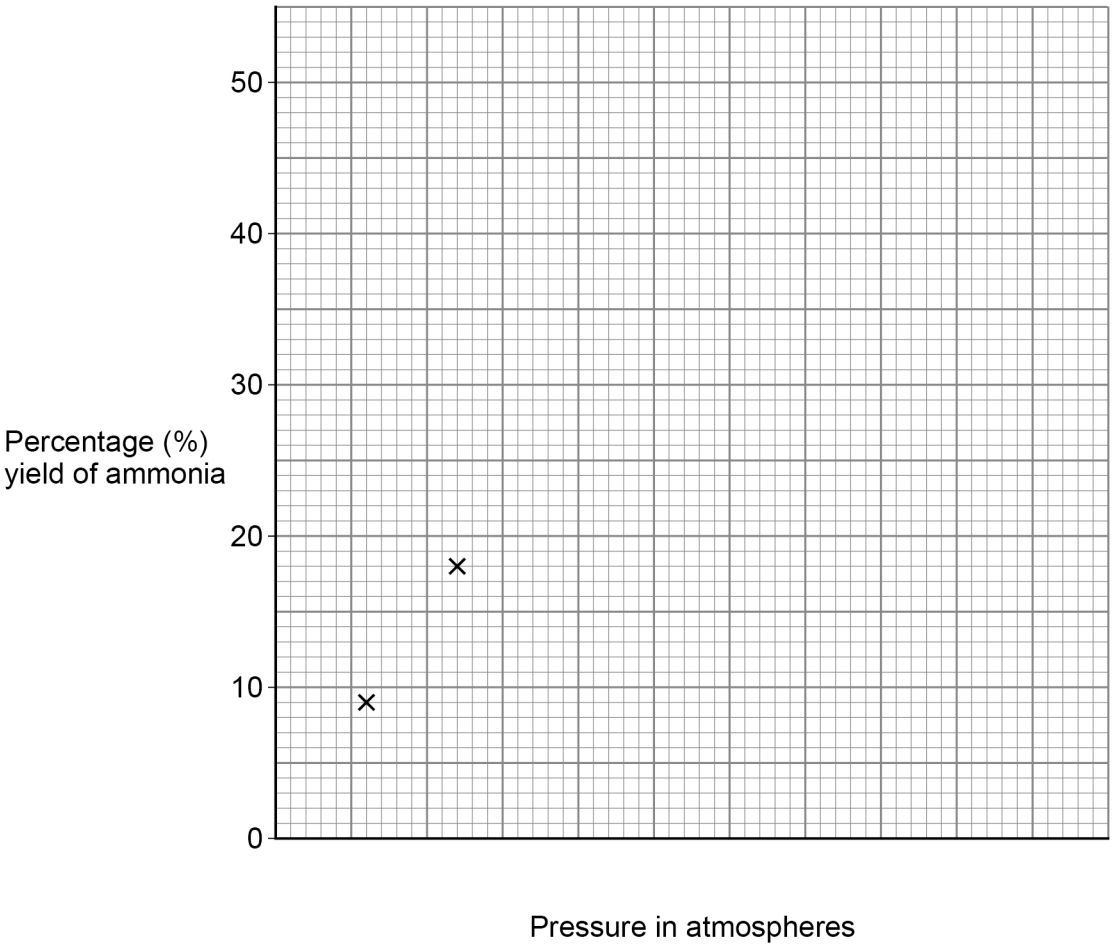
The first two points have been plotted.

You should:

- use a suitable scale for the *x*-axis
- plot the remaining data from **Table 6**
- draw a line of best fit.

[4 marks]

Figure 5



0 7 . 5 Determine the percentage yield of ammonia at 450 °C and 500 atmospheres.

Show your working on **Figure 5**.

[2 marks]

Percentage yield = _____ %

4.9.1.1 The proportions of different gases in the atmosphere

Question 32 · continued

0 7 . 6 The equation for the production of ammonia in the Haber process is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

The conditions used are:

- a temperature of 450 °C
- a pressure of 200 atmospheres
- the presence of an iron catalyst.

Explain why these conditions are chosen for economical production of ammonia in the Haber process.

You should include references to the rate of reaction and the position of equilibrium.

[6 marks]

17

4.9.1.1 The proportions of different gases in the atmosphere

Question 33

June 2025 | 8462/2H | Original Q4

0 4 The Earth's atmosphere has changed over time.

0 4 . 1 Explain how the percentage of nitrogen changed in the Earth's early atmosphere.

[2 marks]

0 4 . 2 **Table 4** shows the percentage (%) of carbon dioxide present in the Earth's early atmosphere.

Table 4

Time in billions of years ago	Percentage (%) of carbon dioxide in the Earth's early atmosphere
4.5	98
4.0	54
3.5	30
3.0	21

The percentage of carbon dioxide in the Earth's **early** atmosphere changed between 4.5 billion and 3.0 billion years ago.

Give **two** reasons why.

[2 marks]

1

2

4.9.1.1 The proportions of different gases in the atmosphere

Question 33 · continued

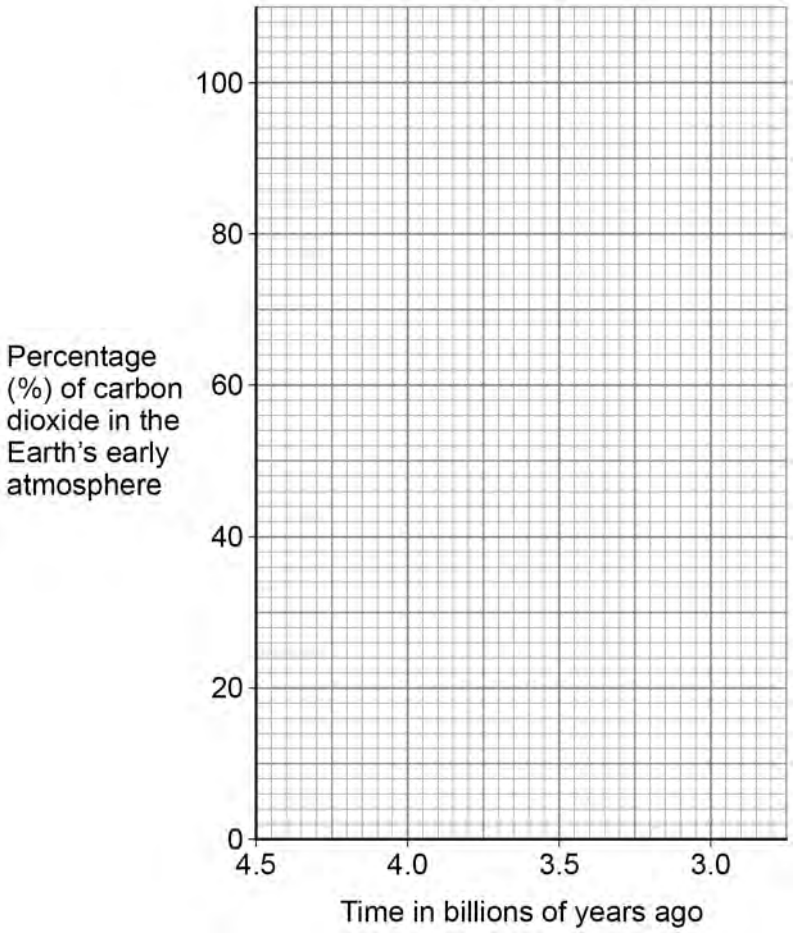
0 4 . 3 Complete **Figure 3**.

You should:

- plot the data in **Table 4**
- draw a line of best fit.

[2 marks]

Figure 3



Question 4 continues on the next page

4.9.1.1 The proportions of different gases in the atmosphere

Question 33 · continued

0 4 . 4 **Table 5** shows information about the percentage (%) of carbon dioxide and of oxygen present in the Earth's atmosphere over time.

Table 5

Time in billions of years ago	Percentage (%) of gas in the Earth's atmosphere	
	Carbon dioxide	Oxygen
2.5	18	1
2.0	15	2
1.5	10	8
1.0	3	17
0.5	1	19

The percentages of carbon dioxide and of oxygen in the Earth's atmosphere changed between 2.5 billion and 0.5 billion years ago.

Explain how.

[3 marks]

9