AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.1.2.4

Group 0

Past-paper questions

Tier	**Higher**
Question groups	**30**
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.

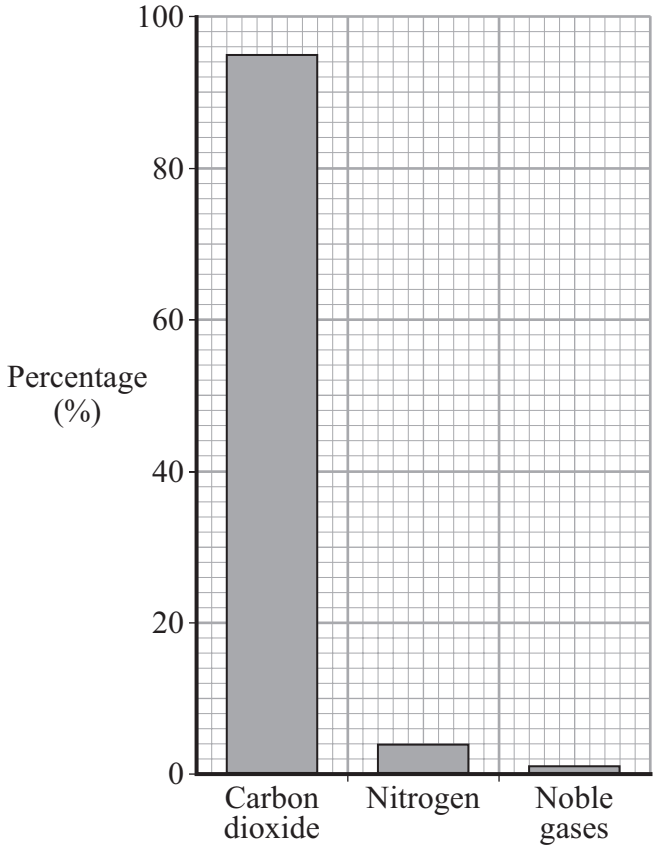
4.1.2.4 Group 0

Question 01

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.

4.1.2.4 Group 0

Question 01 · continued

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.

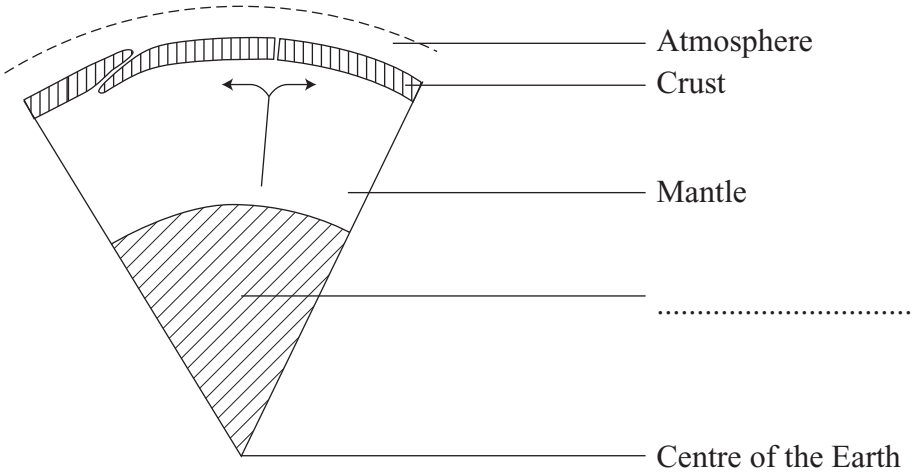
4 ammonia.

4.1.2.4 Group 0

Question 02

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.

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(4 marks)

4.1.2.4 Group 0

Question 02 · continued

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(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.

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(4 marks)

10

4.1.2.4 Group 0

Question 03

November 2007 | CHY1A | Original Q6 | Legacy

QUESTION SIX

The diagram shows part of the periodic table.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
	Be						
Na	Mg	Al	Si	P	S	Cl	Ar
	Ca						
	Sr						

The row of substances from sodium (Na) to argon (Ar) is called a period.

6A Magnesium (Mg) and calcium (Ca) are placed in the same group of the periodic table because they . . .

1 have a similar colour.

2 have similar boiling points.

3 have similar chemical properties.

4 are next to each other in the reactivity series.

6B Magnesium (Mg) and sulfur (S) are in the same period.

Which row in the table below correctly shows one similarity and one difference between magnesium and sulfur?

	Similarity	Difference
1	Both are solids.	Magnesium is a non-metal; sulfur is a metal.
2	Both conduct electricity.	Magnesium is a solid; sulfur is a gas.
3	Both are solids.	Magnesium conducts electricity; sulfur does not.
4	Both conduct electricity.	Magnesium is a metal; sulfur is a non-metal.

4.1.2.4 Group 0

Question 03 · continued

6C Calcium (Ca) is in the periodic table but quicklime is not.

This is because . . .

1 calcium is a metal but quicklime is a non-metal.

2 calcium is an element but quicklime is a compound.

3 calcium is an element but quicklime is an alloy.

4 calcium is a metal but quicklime is a carbonate.

6D The balanced equation which shows the reaction between sodium and chlorine is . . .

1 $Na + Cl_2 \rightarrow NaCl_2$

2 $2Na + Cl_2 \rightarrow Na_2Cl_2$

3 $2Na + Cl_2 \rightarrow 2NaCl$

4 $2Na + 2Cl_2 \rightarrow 2NaCl_2$

4.1.2.4 Group 0

Question 04

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.

4.1.2.4 Group 0

Question 04 · continued

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.

4.1.2.4 Group 0

Question 05

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.

4.1.2.4 Group 0

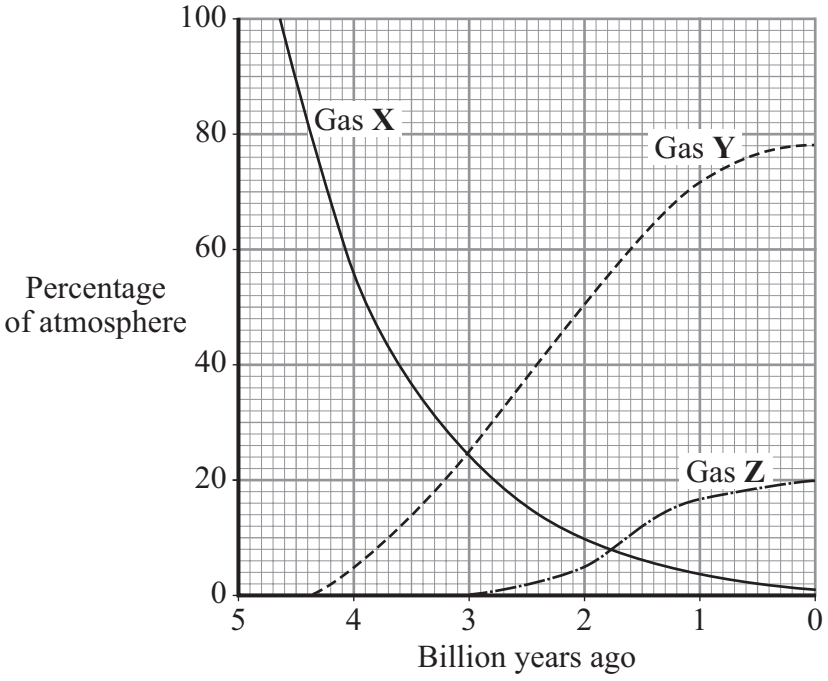
Question 06

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

4.1.2.4 Group 0

Question 06 · continued

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.

4.1.2.4 Group 0

Question 07

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?

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(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.

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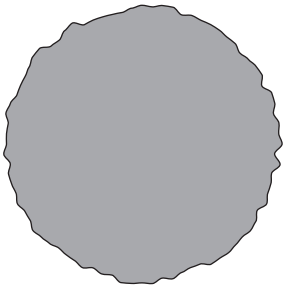
(2 marks)

4.1.2.4 Group 0

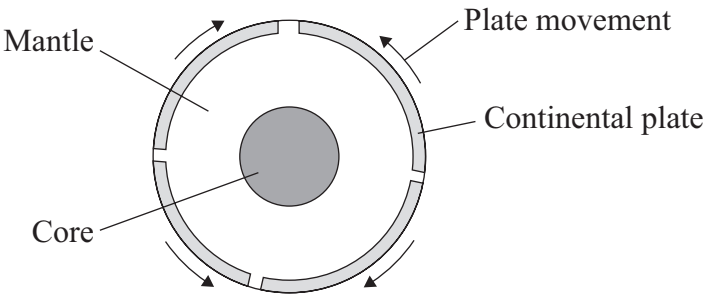
Question 07 · continued

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.

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(1 mark)

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

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(3 marks)

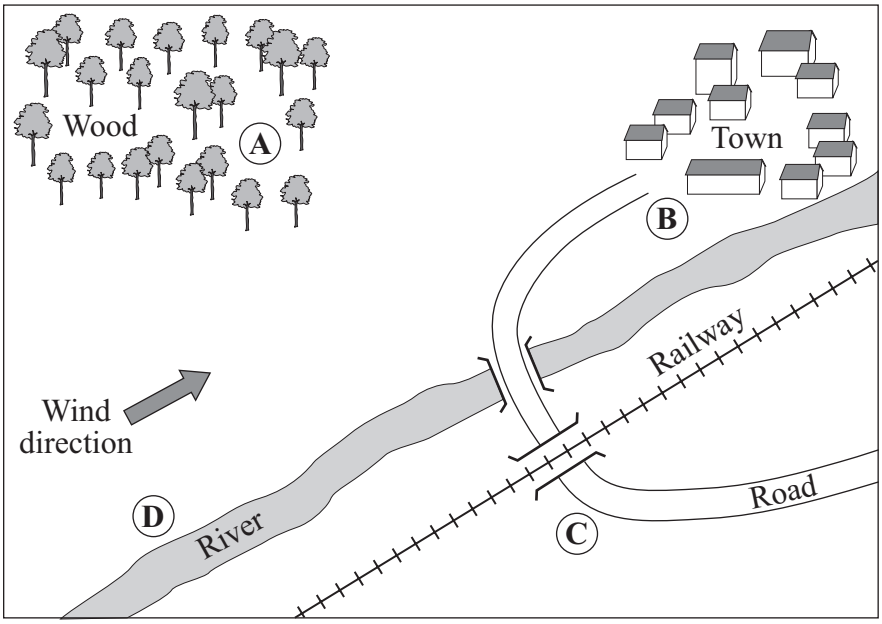
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4.1.2.4 Group 0

Question 08

January 2019 | CHY1H | Original Q7 | Legacy

7 A company wants to extract limestone from an area of natural beauty. The Government has granted permission for the company to take and analyse samples of limestone. The company selects four sites, **A**, **B**, **C** and **D**, within the area and takes four samples from each site.



7 (a) The limestone is analysed by:

- heating 5 g of each sample for 30 minutes
- allowing the sample to cool in a dry, argon atmosphere
- weighing the solid remaining

The table shows the company's results.

Site	Mass of solid remaining in g			
	Sample 1	Sample 2	Sample 3	Sample 4
A	3.15	3.10	3.20	3.19
B	3.25	3.21	3.24	3.26
C	2.85	2.95	2.92	3.00
D	2.98	2.88	2.92	2.82

Limestone is a rock containing calcium carbonate, $CaCO_3$
If the limestone is pure calcium carbonate then the mass of solid remaining would be 2.80 g.

Why does the mass of limestone decrease when it is heated?

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(1 mark)

4.1.2.4 Group 0

Question 08 · continued

for mark

7 (b) Suggest and explain why the solid remaining was cooled in a dry, argon atmosphere.

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(2 marks)

7 (c) Which site, **A**, **B**, **C** or **D**, would you choose for extracting limestone?

Give the advantages **and** disadvantages for your chosen site.

You must explain why you chose this site.

My chosen site is [ ].

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(4 marks)

7

4.1.2.4 Group 0

Question 09

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.

4.1.2.4 Group 0

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.

4.1.2.4 Group 0

Question 10

4 Titanium is used for replacement hip joints because it has a low density, is strong and does not corrode.
Titanium is extracted from titanium dioxide (TiO_2) in three stages.

4 (a) **Stage 1**
Titanium dioxide is converted into titanium chloride ($TiCl_4$) because the metal cannot be extracted from its oxide by *reduction* with carbon.

4 (a) (i) What does *reduction* mean?

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(1 mark)

4 (a) (ii) Balance the chemical equation for the conversion of titanium dioxide to titanium chloride.

TiO_2 + Cl_2 + C → $TiCl_4$ + CO_2

(1 mark)

4 (a) (iii) Chemical equations are always balanced. Explain why.

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(1 mark)

4 (b) **Stage 2**
Titanium is extracted from the titanium chloride by reacting it with sodium at 1000 °C in a reactor.
The only other substance in the reactor is argon gas.

$TiCl_4$ + 4Na → Ti + 4NaCl

4 (b) (i) What does this tell you about the reactivity of sodium compared with titanium?

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(1 mark)

4 (b) (ii) Suggest why the reactor contains argon and **not** air.

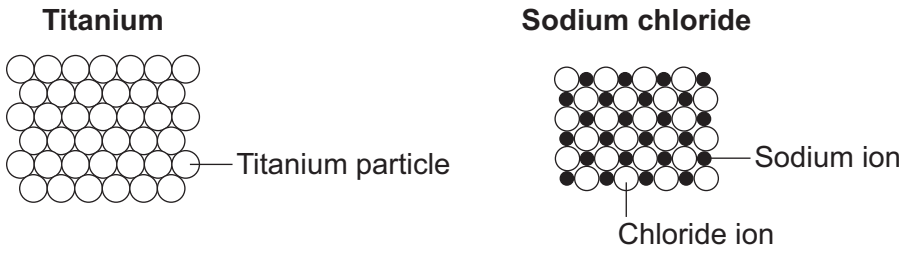
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(1 mark)

4.1.2.4 Group 0

4 (c) **Stage 3**
After **Stage 2** the titanium is separated from the products by washing out the sodium chloride with water.
The diagrams show sections through the lattice of titanium metal and the lattice of sodium chloride.



How do the diagrams show that:

4 (c) (i) titanium is an element

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(1 mark)

4 (c) (ii) sodium chloride is a compound?

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(2 marks)

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4.1.2.4 Group 0

Question 11

March 2011 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

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

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

To separate these gases, they are compressed and cooled.

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

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

1 They are both compounds and the rest are elements.

2 They both contribute to global warming.

3 They would both solidify and block the pipes.

4 The carbon dioxide would dissolve in the water.

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

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

4.1.2.4 Group 0

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

1 helium

2 oxygen

3 nitrogen

4 argon

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

1 oxygen, nitrogen, argon

2 nitrogen, argon, oxygen

3 argon, nitrogen, oxygen

4 oxygen, argon, nitrogen

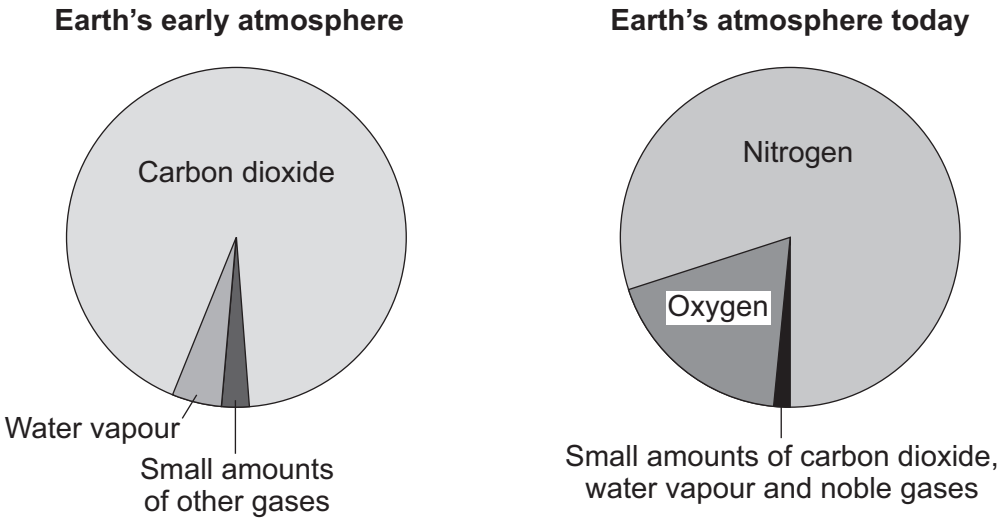
Turn over for the next question

4.1.2.4 Group 0

Question 12

QUESTION THREE

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



3A Very small amounts of a hydrocarbon gas are thought to have been in the Earth's early atmosphere.

This gas is . . .

1 ammonia, NH_3

2 helium, He

3 methane, CH_4

4 oxygen, O_2

4.1.2.4 Group 0

Question 12 · continued

3B As the Earth's early atmosphere was forming, it contained water vapour.

Which row in the table shows where the water vapour came from **and** why the quantity in the atmosphere reduced?

	Water vapour came from	Water vapour reduced because
1	evaporation from the ground.	it condensed to form the oceans.
2	evaporation from the ground.	there was less rainfall.
3	volcanic activity.	it condensed to form the oceans.
4	volcanic activity.	there was less rainfall.

3C Why was there no oxygen in the Earth's early atmosphere?

1 There was no carbon dioxide for the plants to use to make oxygen.

2 Living organisms had used up the oxygen.

3 There were no plants on Earth.

4 Oxygen is a very reactive gas.

3D The quantity of carbon dioxide in the Earth's atmosphere today is very different from the quantity that was in the Earth's early atmosphere.

One of the reasons why it is very different is that . . .

1 there are a lot of cars on our roads today.

2 it is locked up as carbon in fossil fuels.

3 most homes use fossil fuels for central heating.

4 plants produce carbon dioxide by photosynthesis.

4.1.2.4 Group 0

Question 13

June 2011 | CHY1BP | Original Q9 | Legacy

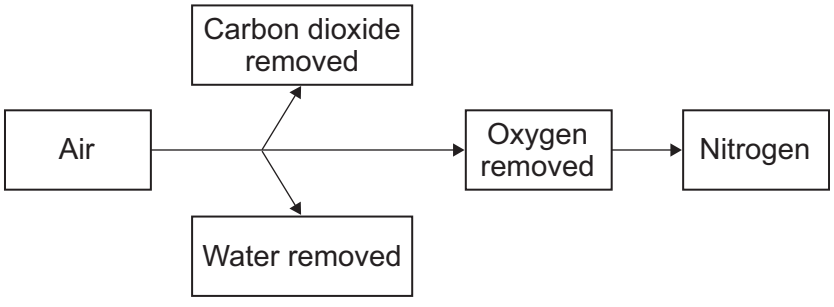
QUESTION NINE

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

4.1.2.4 Group 0

Question 13 · continued

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

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

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

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

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

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

This was because these other gases . . .

1 are colourless.

2 have a very low density.

3 are unreactive.

4 have very low boiling points.

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

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

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

1 It is present only in very small quantities.

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

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

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

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

1 argon, nitrogen, oxygen

2 oxygen, nitrogen, argon

3 nitrogen, argon, oxygen

4 argon, oxygen, nitrogen

END OF TEST

4.1.2.4 Group 0

Question 14

November 2011 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

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

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

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

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

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

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

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

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

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

1 23 g

2 92 g

3 190 g

4 234 g

4.1.2.4 Group 0

Question 14 · continued

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

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

Which two of these reasons are correct?

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

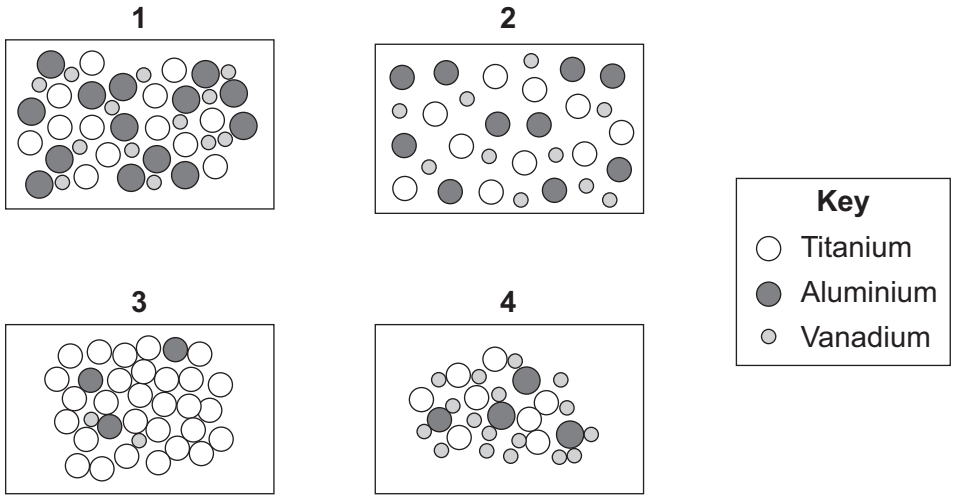
2 **K** and **L**

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

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

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

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



4.1.2.4 Group 0

Question 15

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** . . . .

4.1.2.4 Group 0

Question 16

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

4.1.2.4 Group 0

Question 16 · 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?

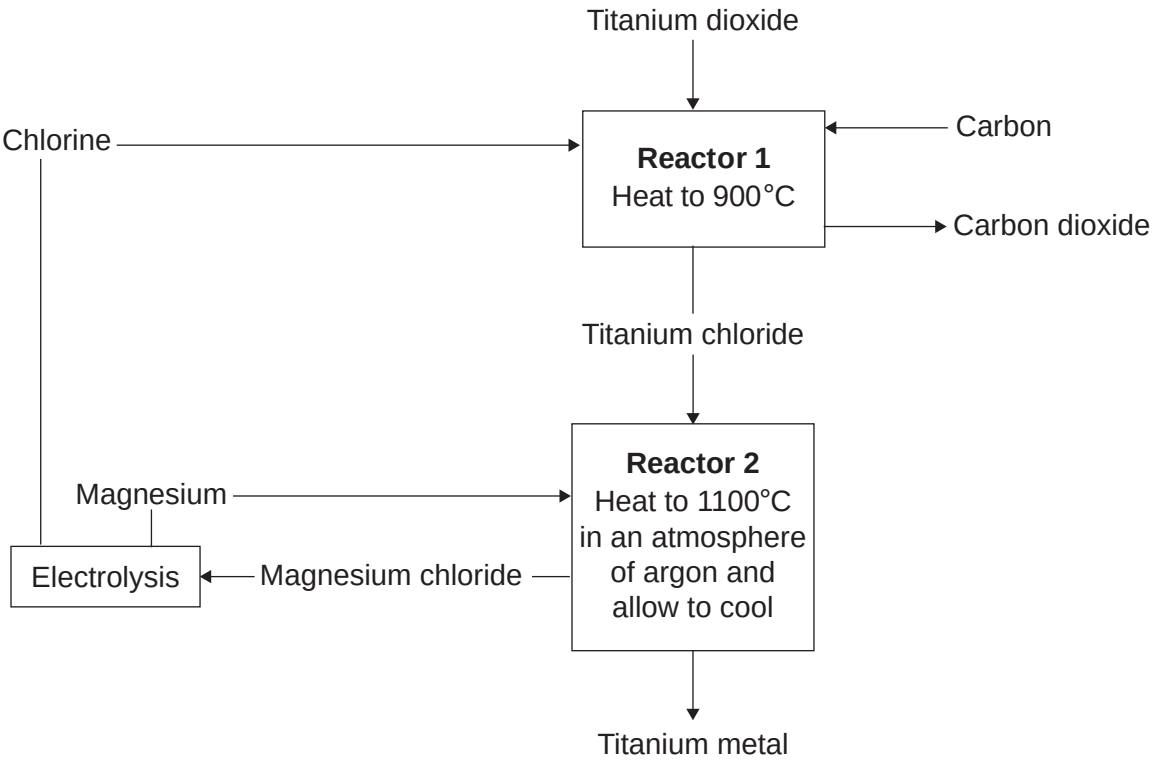
	Instrument reading to . . .	How readings are taken and used
1	10 parts per million	In several locations in a small area and take an average
2	2 parts per million	Average the highest and lowest values obtained
3	10 parts per million	Take values from industrialised areas and take an average
4	2 parts per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

4.1.2.4 Group 0

Question 17

June 2012 | CH1HP | Original Q2 | Legacy

2 Rutile is an ore of titanium. Rutile contains titanium dioxide.
The flow chart shows how titanium metal is extracted from titanium dioxide.



2 (a) Titanium is much more expensive than iron.

Give **one** reason why.

.....

.....

(1 mark)

2 (b) Name the only waste product shown on the flow chart.

.....

(1 mark)

4.1.2.4 Group 0

Question 17 · continued

2 (c) Describe the example of recycling shown on the flow chart.

.....

.....

.....

.....

(2 marks)

2 (d) The air is removed from **Reactor 2**. An atmosphere of argon is used for the reaction between titanium chloride and magnesium metal.

Explain why.

.....

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.....

(2 marks)

Question 2 continues on the next page

4.1.2.4 Group 0

Question 17 · continued

2 (e) Titanium metal is produced by reacting titanium chloride with magnesium.

950 kg of titanium chloride was mixed with 240 kg of magnesium metal. The mixture was heated and produced 950 kg of magnesium chloride.

Calculate the mass of titanium metal produced.

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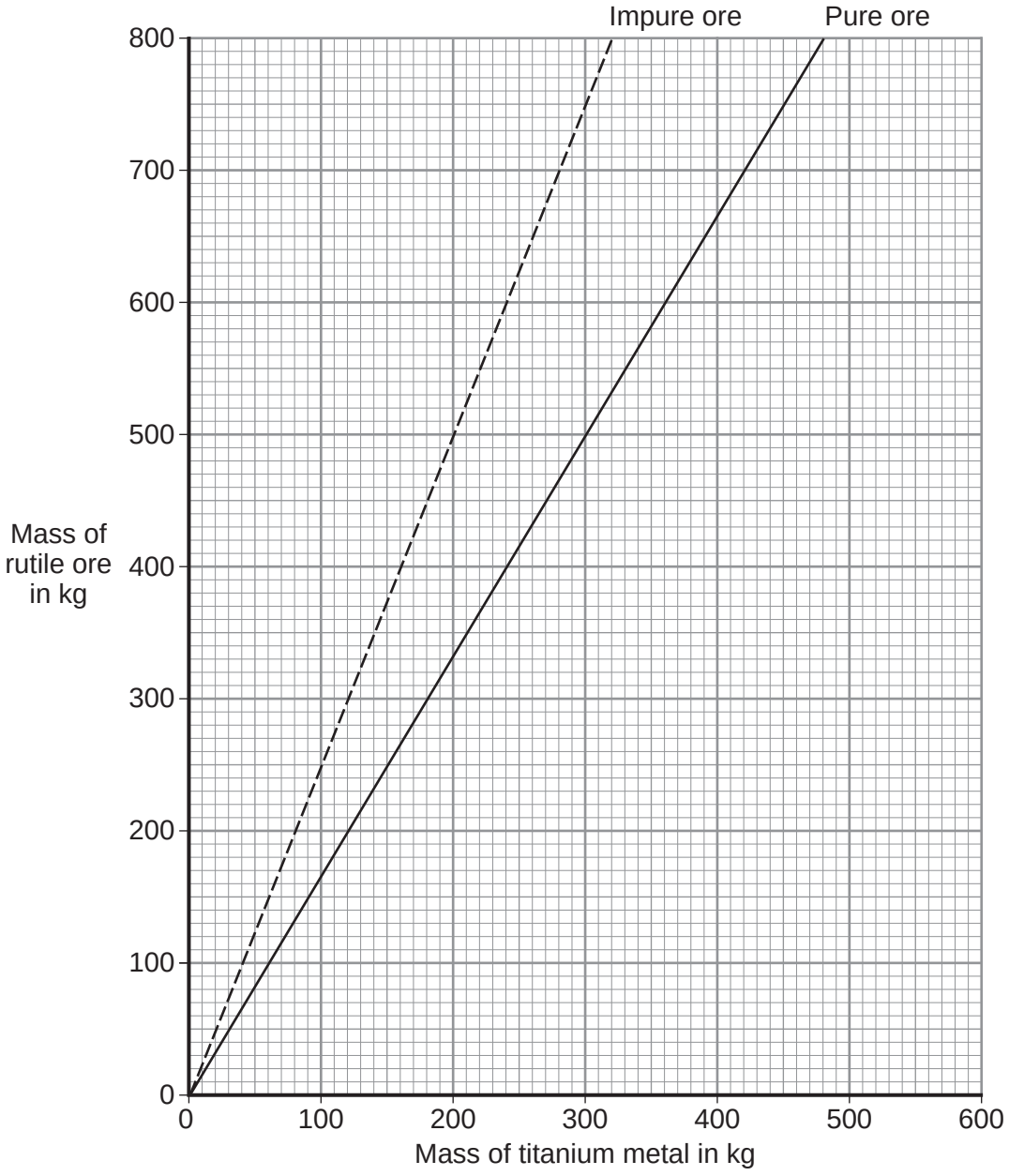
Mass = ... kg

(1 mark)

4.1.2.4 Group 0

Question 17 · continued

2 (f) The graph shows the mass of titanium metal produced from a pure rutile ore and from an impure rutile ore.



The difference between the two lines represents the amount of waste rock in the impure ore.

300 kg of titanium metal was produced from the impure ore.

Calculate the mass of waste rock in the impure ore.

.....

Mass = ... kg

(1 mark)

8

4.1.2.4 Group 0

Question 18

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.

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(2 marks)

4.1.2.4 Group 0

Question 18 · 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.

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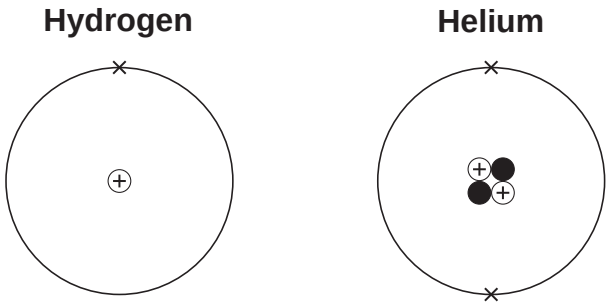
(2 marks)

6

4.1.2.4 Group 0

Question 19

1 The Sun produces helium atoms from hydrogen atoms by nuclear fusion reactions.



1 (a) Describe the differences in the atomic structures of a hydrogen atom and a helium atom.

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(3 marks)

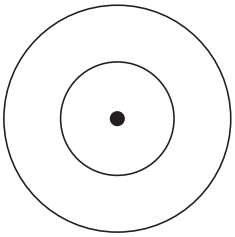
4.1.2.4 Group 0

Question 19 · continued

1 (b) The Sun consists of 73% hydrogen and 25% helium.
The rest is other elements.
One of the other elements in the Sun is neon.

Use the Chemistry Data Sheet to help you to answer these questions.

1 (b) (i) Complete the diagram to show the electronic structure of a neon atom.



(1 mark)

1 (b) (ii) Why is neon in the same group of the periodic table as helium?

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(1 mark)

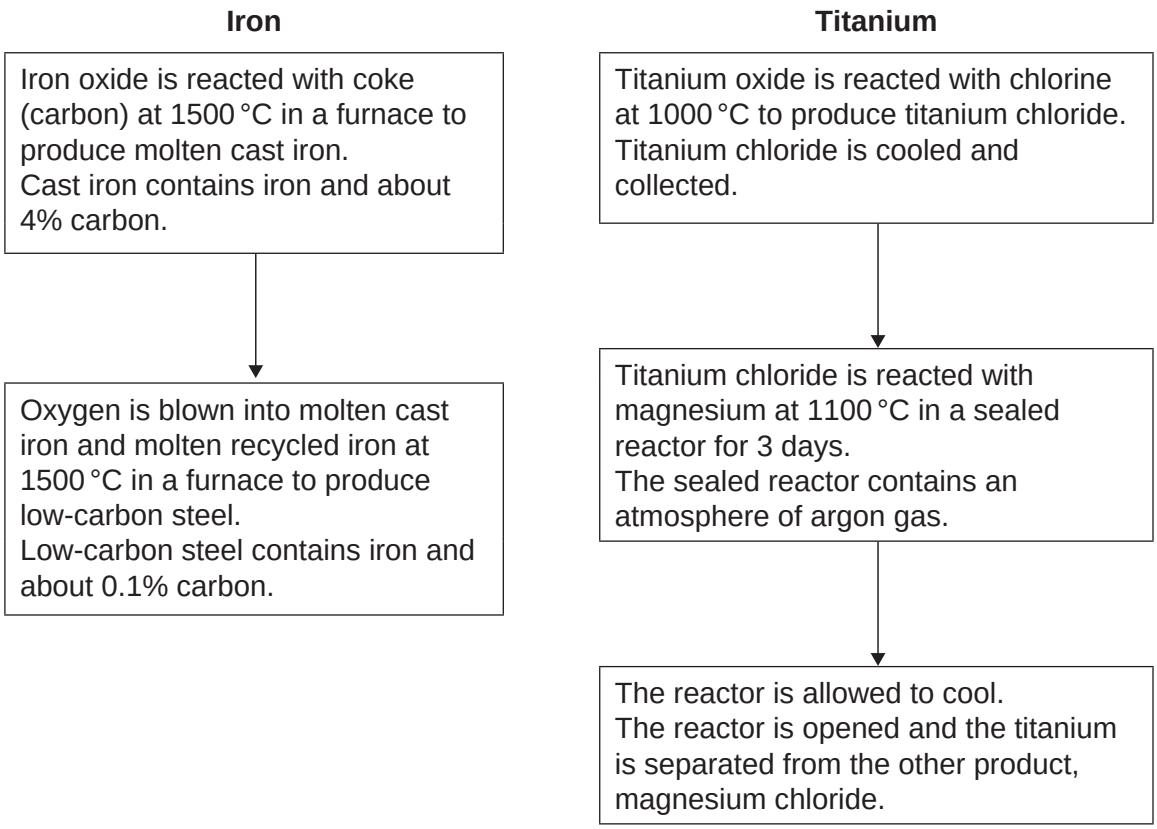
5

4.1.2.4 Group 0

Question 20

7 Iron is produced from the ore haematite (iron oxide).

Titanium is produced from the ore rutile (titanium oxide).



7 (a) The production of low-carbon steel uses oxygen but the production of titanium uses argon.

Explain why.

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(3 marks)

4.1.2.4 Group 0

Question 20 · continued

7 (b) There is less titanium than iron in the Earth's crust.

Apart from titanium's scarcity, explain why titanium costs much more than iron.

Use the two flow diagrams on page 16 to help you to answer this question.

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(3 marks)

7 (c) Many chemical reactions take place in the production of both metals.

A chemical reaction in the production of iron is:

$$2\,Fe_2O_3 + 3\,C \rightarrow 4\,Fe + 3\,CO_2$$

A chemical reaction in the production of titanium is:

$$TiCl_4 + 2\,Mg \rightarrow Ti + 2\,MgCl_2$$

Titanium can be used to produce iron from iron oxide. The chemical reaction is:

$$2\,Fe_2O_3 + 3\,Ti \rightarrow 4\,Fe + 3\,TiO_2$$

Use these three reactions and the Chemistry Data Sheet to answer this question.

Suggest the position of titanium in the Reactivity Series of Metals.

Explain your answer.

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(2 marks)

8

4.1.2.4 Group 0

Question 21

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

Titan is the largest moon of Saturn.

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

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

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

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

Explain your answer.

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.....

(2 marks)

4.1.2.4 Group 0

Question 21 · continued

8 (b) Amino acids are essential to life.

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

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

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

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(4 marks)

6

4.1.2.4 Group 0

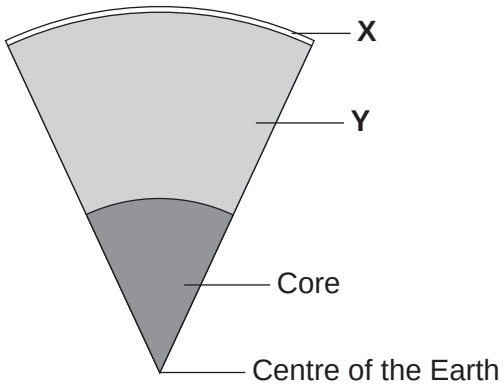
Question 22

June 2014 | CH1HP | Original Q6 | Legacy

6 The Earth is almost spherical and is surrounded by an atmosphere.

Figure 5 shows a section of the layered structure of the Earth.

Figure 5



6 (a) In 1915 Alfred Wegener put forward his idea of continental drift.

6 (a) (i) Why did most scientists in 1915 **not** accept Wegener's idea of continental drift?

[1 mark]

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.....

6 (a) (ii) Describe how **and** explain why continental drift takes place.

Include the names of **X** and **Y** in your answer.

[5 marks]

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4.1.2.4 Group 0

Question 22 · continued

6 (b) **Table 4** shows some properties of gases in the Earth's atmosphere.

Table 4

Gas	Melting point in °C	Boiling point in °C
Argon	–189	–186
Carbon dioxide	–78	–78
Helium	–272	–269
Neon	–249	–246
Nitrogen	–210	–196
Oxygen	–219	–183

These gases are separated by:

- removing carbon dioxide
- cooling the remaining gases to –200 °C
- removing the gases that do not condense
- allowing the liquefied gases to warm up.

6 (b) (i) Suggest **one** reason why carbon dioxide is removed before the gases are cooled to –200 °C.

[1 mark]

.....

.....

6 (b) (ii) Draw a ring around **one** gas that does **not** condense when the remaining gases are cooled to –200 °C.

[1 mark]

argon **neon** **nitrogen** **oxygen**

6 (b) (iii) The oxygen separated by this process contains another gas.

Name the gas and give a reason for your answer.

[2 marks]

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10

4.1.2.4 Group 0

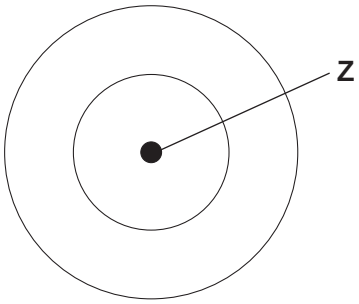
Question 23

June 2016 | CH1HP | Original Q1 | Legacy

1 There are eight elements in the second row (lithium to neon) of the periodic table.

1 (a) **Figure 1** shows an atom with two energy levels (shells).

Figure 1



1 (a) (i) Complete **Figure 1** to show the electronic structure of a boron atom.

[1 mark]

1 (a) (ii) What does the central part labelled **Z** represent in **Figure 1**?

[1 mark]

_____

1 (a) (iii) Name the sub-atomic particles in part **Z** of a boron atom.

Give the relative charges of these sub-atomic particles.

[3 marks]

_____

_____

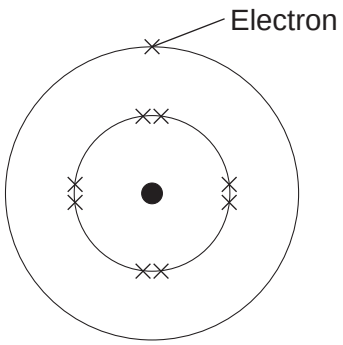
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4.1.2.4 Group 0

Question 23 · continued

1 (b) The electronic structure of a neon atom shown in **Figure 2** is **not** correct.

Figure 2



Explain what is wrong with the electronic structure shown in **Figure 2**.

[3 marks]

8

4.1.2.4 Group 0

Question 24

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]

4.1.2.4 Group 0

Question 24 · 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]

_____

_____

_____

_____

4.1.2.4 Group 0

Question 24 · 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

4.1.2.4 Group 0

Question 25

June 2018 | 8462/1H | Original Q8

0 8 Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two stage industrial process.

Stage 1 $TiO_2 + 2\,C + 2\,Cl_2 \rightarrow TiCl_4 + 2\,CO$

Stage 2 $TiCl_4 + 4\,Na \rightarrow Ti + 4\,NaCl$

0 8 . 1 Suggest **one** hazard associated with **Stage 1**.

[1 mark]

0 8 . 2 Water must be kept away from the reaction in **Stage 2**.

Give **one** reason why it would be hazardous if water came into contact with sodium.

[1 mark]

0 8 . 3 Suggest why the reaction in **Stage 2** is carried out in an atmosphere of argon and **not** in air.

[2 marks]

4.1.2.4 Group 0

Question 25 · continued

0 8 . 4 Titanium chloride is a liquid at room temperature.

Explain why you would **not** expect titanium chloride to be a liquid at room temperature.

[3 marks]

In **Stage 2**, sodium displaces titanium from titanium chloride.

0 8 . 5 Sodium atoms are oxidised to sodium ions in this reaction.

Why is this an oxidation reaction?

[1 mark]

0 8 . 6 Complete the half equation for the oxidation reaction.

[1 mark]

Na → _____ + _____

4.1.2.4 Group 0

Question 25 · continued

0 8 . 7 In **Stage 2**, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:

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

Relative atomic masses (A_r): Na = 23 Cl = 35.5 Ti = 48

Explain why titanium chloride is the limiting reactant.

You **must** show your working.

[4 marks]

0 8 . 8 For a **Stage 2** reaction the percentage yield was 92.3%

The theoretical maximum mass of titanium produced in this batch was 13.5 kg.

Calculate the actual mass of titanium produced.

[2 marks]

Mass of titanium = _____ kg

15

4.1.2.4 Group 0

Question 26

June 2022 | 8462/1H | Original Q5

0 5 This question is about groups in the periodic table.

The elements in Group 1 become more reactive going down the group.

Rubidium is below potassium in Group 1.

0 5 . 1 Rubidium and potassium are added to water.

Predict **one** observation you would see that shows that rubidium is more reactive than potassium.

[1 mark]

0 5 . 2 Explain why rubidium is more reactive than potassium.

[3 marks]

0 5 . 3 Complete the equation for the reaction of rubidium with water.

You should balance the equation.

[3 marks]

$$Rb + H_2O \rightarrow \quad +$$

4.1.2.4 Group 0

Question 26 · continued

The noble gases are in Group 0.

0 5 . 4 Which is a correct statement about the noble gases?

[1 mark]

Tick (✓) **one** box.

The noble gases all have atoms with eight electrons in the outer shell. ☐

The noble gases have boiling points that increase going down the group. ☐

The noble gases have molecules with two atoms. ☐

The noble gases react with metals to form ionic compounds. ☐

0 5 . 5 **Table 1** shows information about the three isotopes of neon.

Table 1

Mass number	Percentage abundance (%)
20	90.48
21	0.27
22	9.25

Calculate the relative atomic mass (A_r) of neon.

Give your answer to 3 significant figures.

[3 marks]

Relative atomic mass (3 significant figures) = _____

11

4.1.2.4 Group 0

Question 27

June 2023 | 8462/1H | Original Q8

0 8 This question is about elements in the periodic table.

0 8 . 1 Argon has the atomic number 18

Explain why argon does **not** form compounds.

Answer in terms of electrons.

[2 marks]

0 8 . 2 Phosphorus (P) is the element below nitrogen in the periodic table.

Predict the formula of the compound formed between phosphorus and hydrogen.

[1 mark]

Formula = _____

0 8 . 3 Tellurium is the element with atomic number 52

Predict whether tellurium reacts with metals.

Explain your answer.

Answer in terms of the position of tellurium in the periodic table.

[2 marks]

4.1.2.4 Group 0

Question 27 · continued

Barium (Ba) is an element in Group 2 of the periodic table.

Barium reacts with hydrochloric acid.

0 8 . 4 Suggest **two** observations that could be made when barium reacts with hydrochloric acid.

[2 marks]

1 _____

_____

2 _____

_____

0 8 . 5 Write a balanced symbol equation for the reaction between barium and hydrochloric acid.

[3 marks]

_____ + _____ → _____ + _____

10

4.1.2.4 Group 0

Question 28

June 2024 | 8462/1H | Original Q2

0 2 This question is about the periodic table.

Sodium and potassium are in Group 1 of the periodic table.

0 2 . 1 Give **one** similarity and **one** difference between the electronic structures of sodium and potassium.

[2 marks]

Similarity _____

_____

Difference _____

_____

Group 1 elements react with water.

0 2 . 2 Give **two** observations made when potassium reacts with water.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 3 Potassium hydroxide solution is produced when potassium reacts with water.

What is the colour of universal indicator when added to potassium hydroxide solution?

Give **one** reason for your answer.

[2 marks]

Colour of universal indicator _____

Reason _____

_____

4.1.2.4 Group 0

Question 28 · continued

Table 1 shows the densities of some of the elements in Group 0 of the periodic table.

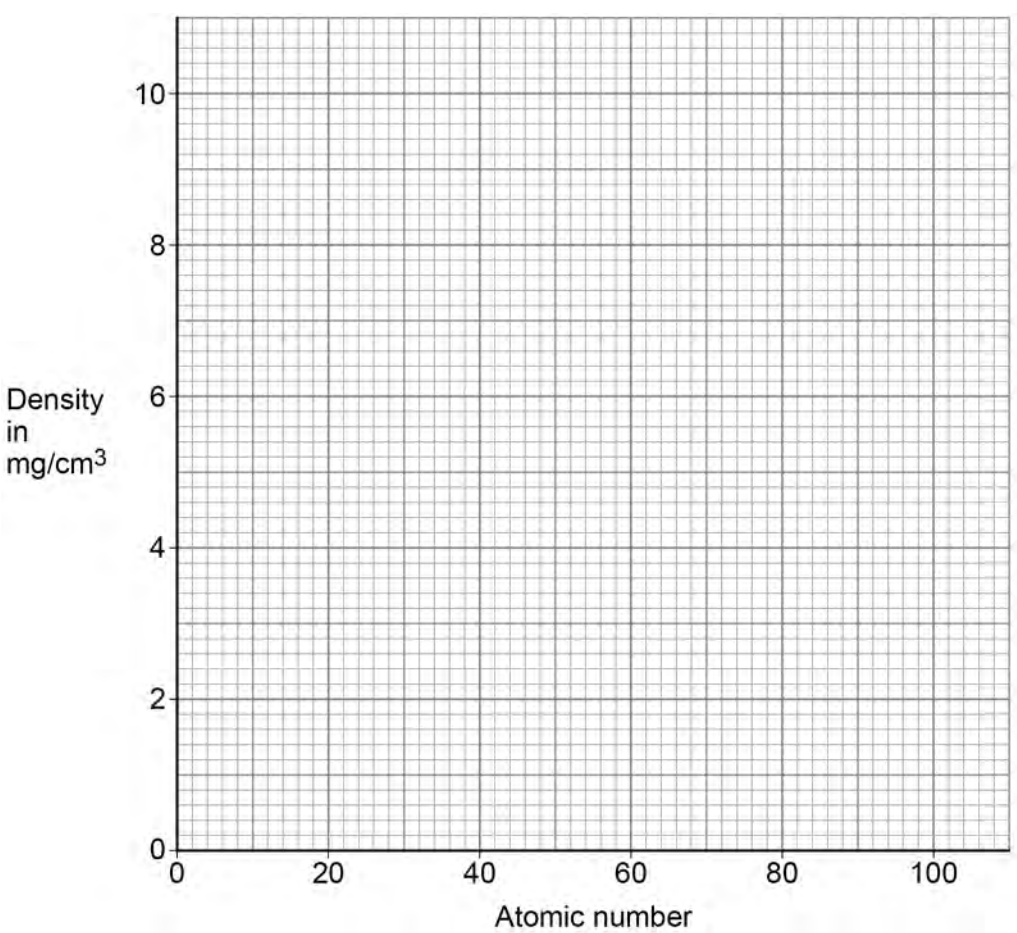
Table 1

Element	Atomic number	Density in mg/cm^3
Helium	2	0.2
Neon	10	0.8
Argon	18	1.6
Krypton	36	**X**
Xenon	54	5.4
Radon	86	9.1

0 2 . 4 Plot the data from **Table 1** on **Figure 1**.

[2 marks]

Figure 1



4.1.2.4 Group 0

Question 28 · continued

0 2 . 5 Estimate the density (**X**) of krypton.

Use **Figure 1** and **Table 1**.

[1 mark]

Density = _____ mg/cm^3

0 2 . 6 The elements in Group 7 are called the halogens.

A more reactive halogen can displace a less reactive halogen from a solution of its salt.

Which combination of solutions will produce a reaction when mixed?

[1 mark]

Tick (✓) **one** box.

- Chlorine and potassium fluoride ☐
- Chlorine and potassium bromide ☐
- Bromine and potassium fluoride ☐
- Bromine and potassium chloride ☐

0 2 . 7 Which of the following describes the trends going down Group 7?

[1 mark]

Tick (✓) **one** box.

- Relative molecular mass decreases and boiling point decreases. ☐
- Relative molecular mass decreases and boiling point increases. ☐
- Relative molecular mass increases and boiling point decreases. ☐
- Relative molecular mass increases and boiling point increases. ☐

11

4.1.2.4 Group 0

Question 29

June 2025 | 8462/1H | Original Q1

0 1 This question is about elements in the periodic table.

0 1 . 1 Describe where the non-metallic elements are found in the periodic table.

[1 mark]

0 1 . 2 Gallium (Ga) is a metallic element in Group 3.

Which of these properties of gallium is **not** typical of most metals?

[1 mark]

Tick (✓) **one** box.

- A boiling point above 1000 °C ☐
- A melting point below 100 °C ☐
- Conducts electricity when solid ☐
- Forms positive ions ☐

4.1.2.4 Group 0

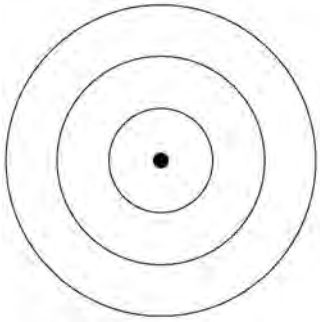
Question 29 · continued

0 1 . 3 A sodium atom can be represented as $^{23}_{11}Na$

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

[1 mark]

Figure 1



0 1 . 4 Mendeleev created an early periodic table.

Mendeleev placed most of the elements in order of atomic weight.

Tellurium and iodine were not placed in order of atomic weight.

Why did Mendeleev **not** place tellurium and iodine in order of atomic weight?

[1 mark]

0 1 . 5 Argon is an element in Group 0 of the periodic table.

Explain why argon is unreactive.

[2 marks]

Question 29 · continued

An element **X** consists of two isotopes.

0 1 . 6 What is meant by 'isotopes'?

Answer in terms of subatomic particles.

[2 marks]

0 1 . 7 **Table 1** shows the mass numbers and percentage abundances of the isotopes of **X**.

Table 1

Mass number	Percentage abundance (%)
113	4
115	96

Which is the closest estimate to the relative atomic mass of **X**?

[1 mark]

Tick (✓) **one** box.

~113 ☐ ~114 ☐ ~115 ☐

9

4.1.2.4 Group 0

Question 30

June 2025 | 8462/1H | Original Q5

0 5 This question is about small particles.

Before the discovery of the electron, atoms were thought to be tiny spheres that could not be divided.

0 5 . 1 The discovery of the electron led to the plum pudding model of the atom.

Describe the plum pudding model of the atom.

[2 marks]

0 5 . 2 The model of the atom changed again after the alpha particle scattering experiment.

Give **two** conclusions that were made from the alpha particle scattering experiment.

[2 marks]

1

2

0 5 . 3 Niels Bohr made another change to the model of the atom.

What was this change?

[1 mark]

4.1.2.4 Group 0

Question 30 · continued

0 5 . 4 A helium atom has a radius of 1.4×10^{-10} m.

The nucleus of this atom has a radius of 1.7×10^{-15} m.

How many times larger is the radius of the atom than the radius of the nucleus?

[1 mark]

Tick (✓) **one** box.

~1000 times larger ☐

~10 000 times larger ☐

~100 000 times larger ☐

~1 000 000 times larger ☐

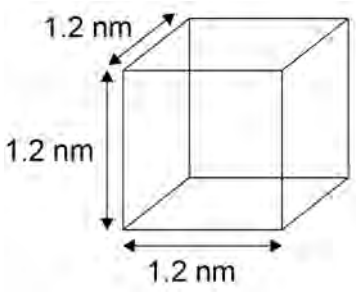
4.1.2.4 Group 0

Question 30 · continued

Nanoparticles contain a few hundred atoms.

0 5 . 5 **Figure 5** represents a cubic nanoparticle.

Figure 5



Calculate the simplest surface area : volume ratio of the cubic nanoparticle.

[4 marks]

Simplest surface area to volume ratio = _____ : _____

0 5 . 6 Lenses in reading glasses often have a scratch-resistant coating that contains a hard substance.

Nanoparticles of the hard substance are used instead of fine particles of the hard substance.

Explain why nanoparticles are used instead of fine particles.

[2 marks]

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