AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.3.1.2

Relative formula mass

Past-paper questions

Tier	**Foundation**
Question groups	**51**
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.

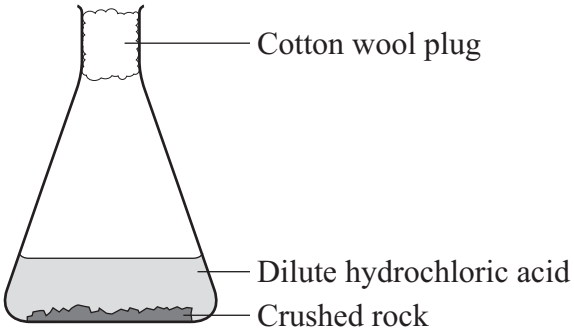
4.3.1.2 Relative formula mass

Question 01 June 2007 | CHY1A | Original Q9 | Legacy

QUESTION NINE

A student wanted to find the percentage (%) of calcium carbonate in a rock sample that she had collected.

She used a small piece of the sample, crushed it, weighed it, and then set up her experiment as shown.



Bubbles of carbon dioxide were given off as the calcium carbonate in the crushed rock reacted with the acid.
She allowed the reaction to continue until no more bubbles were seen.

9A The student assumed that all the calcium carbonate in the samples had reacted when the bubbles stopped.

What else should she do to be sure that it had all reacted?

1 test to see whether there is any acid left in the mixture

2 allow the contents of the flask to cool to room temperature

3 add alkali to neutralise the solution in the flask

4 test to see whether there is any carbon dioxide in the flask

4.3.1.2 Relative formula mass

9B The student did the experiment four times and calculated the following results for the percentage of calcium carbonate in the rock.

67 %, 50 %, 39 %, 56 %

What is the mean of her results?

1 28 %

2 53 %

3 56 %

4 67 %

9C One possible reason why there is so much variation in the four results is that . . .

1 there was an increase in the laboratory temperature.

2 there was a decrease in the laboratory temperature.

3 the hydrochloric acid was too strong.

4 calcium carbonate is not spread evenly through the rock sample.

9D A systematic error in the student's technique that could produce incorrect results is that . . .

1 other substances in the rock may react with hydrochloric acid.

2 the same mass of crushed rock was not used in each experiment.

3 the balance was not zeroed before each weighing.

4 a mistake was made in a calculation.

END OF TEST

4.3.1.2 Relative formula mass

Question 02

January 2008 | CHY2F | Original Q8 | Legacy

8 (a) A chemist was asked to identify a nitrogen compound. The chemist carried out an experiment to find the relative formula mass (M_r) of the compound.

The M_r of the compound was **44**.

Relative atomic masses: N = 14, O = 16

Draw a ring around the formula of the compound.

NO **NO_2** **N_2O_4** **N_2O**

(1 mark)

(b) Potassium nitrate is another nitrogen compound. It is used in fertilisers.
It has the formula **KNO_3**.

The M_r of potassium nitrate is **101**.

Calculate the percentage of **nitrogen** by mass in potassium nitrate.

Relative atomic mass: N = 14.

.....

.....

Percentage of nitrogen = ... %

(2 marks)

3

4.3.1.2 Relative formula mass

Question 03

June 2008 | CHY2F | Original Q7 | Legacy

7 Toothpastes often contain fluoride ions to help protect teeth from attack by bacteria.



Some toothpastes contain tin(II) fluoride.

This compound has the formula SnF_2.

7 (a) Calculate the relative formula mass (M_r) of SnF_2.
Relative atomic masses: F = 19; Sn = 119

.....

.....

.....

.....

Relative formula mass (M_r) = ...
(2 marks)

7 (b) Calculate the percentage by mass of fluorine in SnF_2.

.....

.....

.....

.....

Percentage by mass of fluorine = ... %
(2 marks)

4.3.1.2 Relative formula mass

Question 03 · continued

for mark

7 (c) A tube of toothpaste contains 1.2 g of SnF_2.

Calculate the mass of fluorine in this tube of toothpaste.

.....

.....

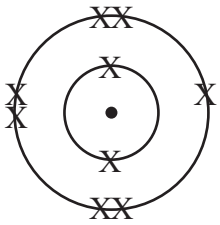
.....

.....

Mass of fluorine = ... g

(1 mark)

7 (d) The diagram represents the electron arrangement of a fluorine atom.



Explain how a fluorine atom can change into a fluoride ion, F^-.

.....

.....

.....

.....

(2 marks)

7

4.3.1.2 Relative formula mass

Question 04

June 2009 | CHY2F | Original Q8 | Legacy

8 This question is about methods of treating water.

8 (a) Chlorine is used to kill microorganisms in water. When chlorine is added to water a chemical reaction takes place. The equation for this reaction is shown below.

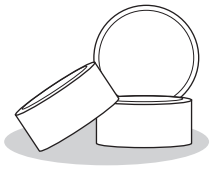
$$Cl_2(g) + H_2O(l) \rightleftharpoons 2H^+(aq) + OCl^-(aq) + Cl^-(aq)$$

An acidic solution is produced when chlorine reacts with water.

Which ion, shown in the equation, makes the solution acidic? .....

(1 mark)

8 (b) Calcium hypochlorite tablets are added to water in some swimming pools to kill microorganisms.



The formula of calcium hypochlorite is $CaCl_2O_2$

8 (b) (i) Calculate the relative formula mass (M_r) of calcium hypochlorite.

Relative atomic masses: O = 16; Cl = 35.5; Ca = 40.

.....

.....

Relative formula mass (M_r) of calcium hypochlorite = ...

(2 marks)

8 (b) (ii) Calculate the percentage by mass of chlorine in calcium hypochlorite.

.....

.....

Percentage by mass of chlorine in calcium hypochlorite = ... %

(2 marks)

4.3.1.2 Relative formula mass

Question 04 · continued

for mark

8 (b) (iii) Calculate the mass of chlorine in a 20 g tablet of calcium hypochlorite.

.....

.....

Mass of chlorine = ... g

(1 mark)

8 (c) Waste water from some industrial processes sometimes contains harmful metal ions, such as chromium ions. These ions must be removed from the water before it can be returned to a river.
A method of removing chromium ions (Cr^{3+}) from water is represented by this equation.

$$Cr^{3+}(aq) + 3OH^{-}(aq) \rightarrow Cr(OH)_3(s)$$

8 (c) (i) What type of substance would be added to the water to provide the OH^- ions?

.....

.....

(1 mark)

8 (c) (ii) A *precipitate* is formed in this reaction.

What is a *precipitate*?

.....

.....

(1 mark)

8 (c) (iii) What method could be used to separate the precipitate from the solution?

.....

.....

(1 mark)

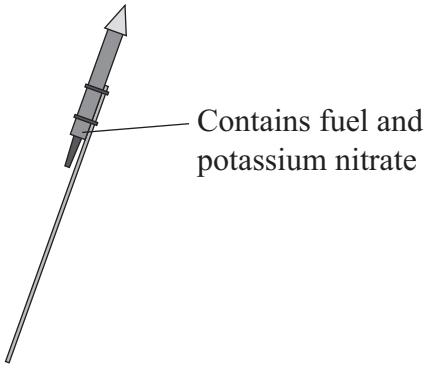
9

4.3.1.2 Relative formula mass

Question 05

January 2010 | CHY2F | Original Q5 | Legacy

5 Firework rockets contain fuel and potassium nitrate.



The potassium nitrate provides oxygen for the fuel to react.

5 (a) The table shows how a student worked out the relative formula mass (M_r) of potassium nitrate.

Some of the numbers are missing.

Relative atomic masses (A_r): N = 14; O = 16; K = 39.

Name of atom (symbol)	Number of atoms	A_r	Mass
potassium (K)	1	39	39
nitrogen (N)	1	14	14
oxygen (O)		16	
		The M_r of potassium nitrate =	101

5 (a) (i) The mass of oxygen is not shown in the table.

Draw a ring around the correct mass of oxygen.

16 **32** **48**

(1 mark)

5 (a) (ii) Draw a ring around the number of oxygen atoms in the formula of potassium nitrate.

1 **2** **3**

(1 mark)

4.3.1.2 Relative formula mass

Question 05 · continued

for mark

5 (b) When the fuel reacts with the oxygen an *exothermic* reaction takes place.

What does *exothermic* mean?

.....

.....

.....

.....

(2 marks)

5 (c) The fuel contains carbon. Carbon reacts with oxygen to make carbon dioxide.

Which **two** statements in the table explain why carbon dioxide is a gas at room temperature?

Tick (✓) the **two** statements.

Statement	**Tick (✓)**
It has a giant structure	
It has a low boiling point.	
It is made of small molecules.	
It is made of ions.	

(2 marks)

6

4.3.1.2 Relative formula mass

Question 06

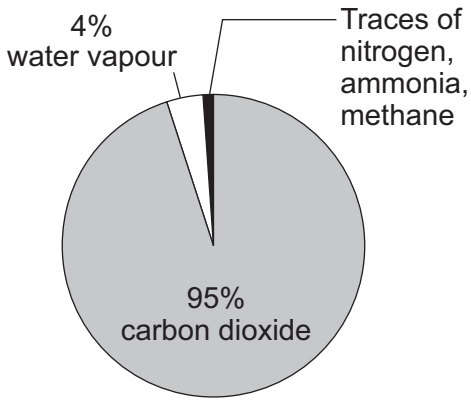
June 2019 | CHY1F | Original Q6 | Legacy

6 (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.

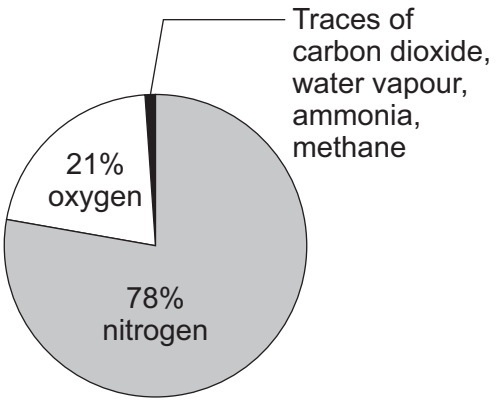
The pie charts show the approximate percentages of gases in the Earth's early atmosphere and in the Earth's atmosphere today.

Earth's early atmosphere



Average surface temperature above 400 °C

Earth's atmosphere today



Average surface temperature 20 °C

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

.....

.....

.....

.....

(2 marks)

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

1 .....

.....

2 .....

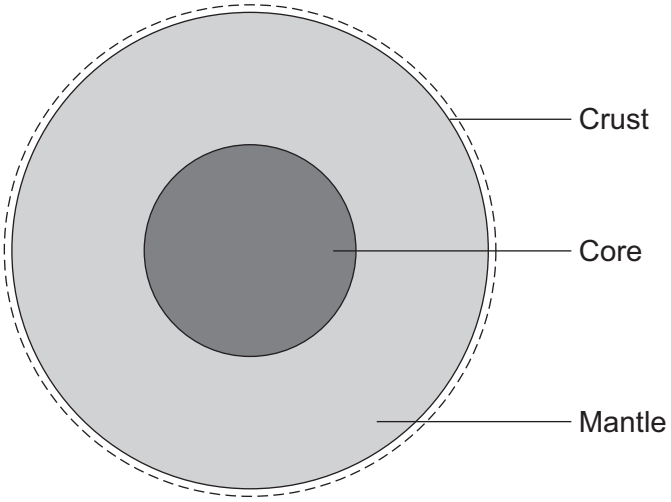
.....

(2 marks)

4.3.1.2 Relative formula mass

Question 06 · continued

6 (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.

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

.....

.....

(1 mark)

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

.....

.....

.....

.....

.....

.....

(3 marks)

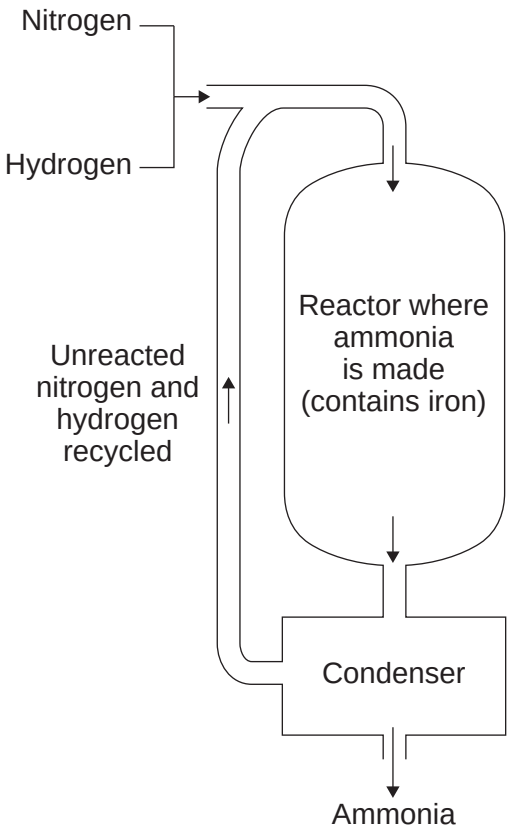
8

4.3.1.2 Relative formula mass

Question 07

June 2010 | CHY2F | Original Q6 | Legacy

6 (a) The diagram shows how ammonia is made.



6 (a) (i) Complete the word equation for the reaction that takes place in the reactor.

nitrogen + ... → .....

(1 mark)

6 (a) (ii) Ammonia is made by passing nitrogen and hydrogen over hot iron.
Why is iron used in the reactor?

.....

.....

(1 mark)

6 (a) (iii) Explain how ammonia is separated from the unreacted nitrogen and hydrogen.

.....

.....

.....

.....

(2 marks)

4.3.1.2 Relative formula mass

Question 07 · continued

6 (b) Ammonia is used to make the fertiliser ammonium nitrate.

Calculate the relative formula mass (M_r) of ammonium nitrate, NH_4NO_3

Relative atomic masses (A_r): H = 1; N = 14; O = 16

.....

.....

.....

.....

Relative formula mass = ...

(2 marks)

6 (c) Another fertiliser is potassium nitrate, KNO_3

The relative formula mass (M_r) of potassium nitrate is 101.

Relative atomic masses (A_r): N = 14; O = 16; K = 39

The table shows the percentage by mass of potassium and nitrogen in four fertilisers, **A**, **B**, **C** and **D**.

Fertiliser	Percentage by mass of potassium (%)	Percentage by mass of nitrogen (%)
A	12.45	25.21
B	19.91	24.12
C	38.61	13.86
D	24.89	9.25

Which fertiliser, **A**, **B**, **C** or **D**, is potassium nitrate?

You **must** show your working to gain full marks.

.....

.....

.....

.....

Potassium nitrate is fertiliser ☐

(2 marks)

8

4.3.1.2 Relative formula mass

Question 08

November 2010 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

This question is about four planets, **A**, **B**, **C** and **D**, in the Solar System.

	Planet	Atmosphere	Average surface temperature in °C
A	Venus	97 % carbon dioxide, 3 % nitrogen	460
B	Earth	78 % nitrogen, 21 % oxygen, 1 % noble gases	14
C	Mars	96 % carbon dioxide, 2 % nitrogen, 2 % noble gases	–46
D	Jupiter	87 % hydrogen, 13 % helium	–121

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

1	Its atmosphere has the highest percentage of carbon dioxide.
2	It has green plants growing on its surface.
3	It has the lowest surface temperature.
4	Its atmosphere contains nitrogen, but at the lowest percentage.

4.3.1.2 Relative formula mass

Question 09

7 Calamine lotion is used to treat itching. The main ingredients are two metal oxides.



7 (a) One of the metal oxides has a relative formula mass (M_r) of 81.

The formula of this metal oxide is MO.
(M is **not** the correct symbol for the metal.)

The relative atomic mass (A_r) of oxygen is 16.

7 (a) (i) Calculate the relative atomic mass (A_r) of metal M.

.....

.....

.....

Relative atomic mass (A_r) = ...

(2 marks)

7 (a) (ii) Use your answer to part (a)(i) and the periodic table on the Data Sheet to name metal M.

The name of metal M is ..... .

(1 mark)

4.3.1.2 Relative formula mass

Question 09 · continued January 2011 | CHY2F | Original Q7 | Legacy

7 (b) The other metal oxide is iron(III) oxide.

This contains iron(III) ions (Fe^{3+}) and oxide ions (O^{2-}).

7 (b) (i) Explain in terms of electrons how an iron atom (Fe) can change into an iron(III) ion (Fe^{3+}).

.....

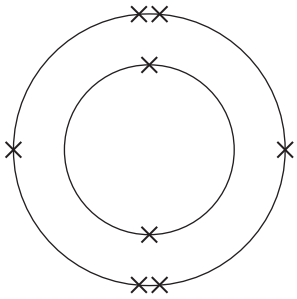
.....

.....

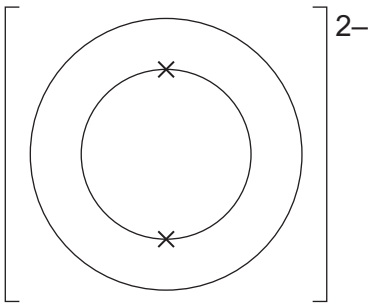
.....

(2 marks)

7 (b) (ii) The diagram below represents the electronic structure of an oxygen atom (O).



Complete the diagram below to show the electronic structure of an oxide ion (O^{2-}).



(1 mark)

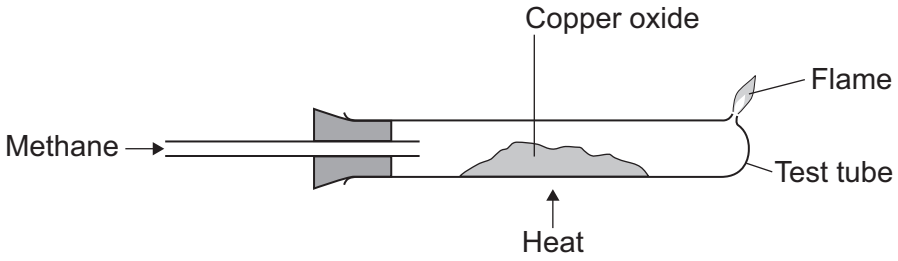
6

4.3.1.2 Relative formula mass

Question 10

June 2011 | CHY2F | Original Q7 | Legacy

7 An experiment was done on the reaction of copper oxide (CuO) with methane (CH_4).



7 (a) The equation for this reaction is shown below.

$$4CuO(s) + CH_4(g) \rightarrow 4Cu(s) + 2H_2O(g) + CO_2(g)$$

The water and carbon dioxide produced escapes from the test tube.

Use information from the equation to explain why.

.....

(1 mark)

7 (b) (i) Calculate the relative formula mass (M_r) of copper oxide (CuO).

Relative atomic masses (A_r): O = 16; Cu = 64.

.....

.....

.....

Relative formula mass (M_r) = ...

(2 marks)

7 (b) (ii) Calculate the percentage of copper in copper oxide.

.....

.....

.....

Percentage of copper = ... %

(2 marks)

4.3.1.2 Relative formula mass

Question 10 · continued June 2011 | CHY2F | Original Q7 | Legacy

7 (b) (iii) Calculate the mass of copper that could be made from 4.0 g of copper oxide.

.....

.....

Mass of copper = ... g
(1 mark)

7 (c) The experiment was done three times.
The mass of copper oxide used and the mass of copper made was measured each time.
The results are shown in the table.

	Experiment		
	1	**2**	**3**
Mass of copper oxide used in g	4.0	4.0	4.0
Mass of copper made in g	3.3	3.5	3.2

7 (c) (i) Calculate the mean mass of copper made in these experiments.

.....

.....

Mean mass of copper made = ... g
(1 mark)

7 (c) (ii) Suggest how the results of these experiments could be made more precise.

.....

.....
(1 mark)

7 (c) (iii) The three experiments gave slightly different results for the mass of copper made.
This was caused by experimental error.

Suggest **two** causes of experimental error in these experiments.

1 .....

.....

2 .....

.....
(2 marks)

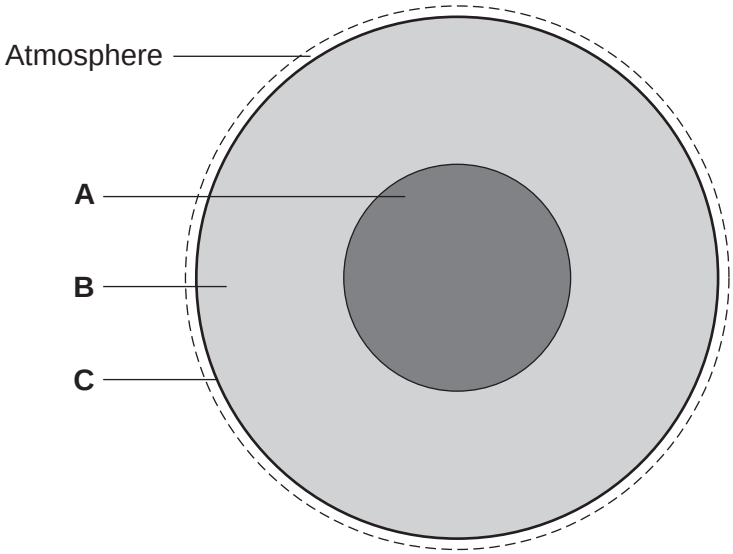
10

4.3.1.2 Relative formula mass

Question 11

June 2012 | CH1FP | Original Q2 | Legacy

2 This is a diagram of the layered structure of the Earth.



Earth

2 (a) Draw a line from each layer to the correct name of the layer.

Layer	Name
Layer **A**	core
Layer **B**	crust
Layer **C**	mantle
	nucleus

(3 marks)

4.3.1.2 Relative formula mass

Question 11 · continued

2 (b) The Earth's early atmosphere was 96% carbon dioxide.
The atmosphere of the Earth today is 0.04% carbon dioxide.

The percentage of carbon dioxide in the Earth's atmosphere has changed.

Give **two** reasons why.

You should consider:

- the formation of surface water (oceans)
- the formation of sedimentary rocks (limestone).

.....

.....

.....

.....

(2 marks)

5

4.3.1.2 Relative formula mass

Question 12

January 2013 | CH2FP | Original Q6 | Legacy

6 Printed pictures can be made using etchings.



An etching can be made when a sheet of brass reacts with iron chloride solution.

6 (a) Brass is a mixture of two metals, copper and zinc.

6 (a) (i) A mixture of two metals is called ..... .

(1 mark)

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

Copper and zinc atoms are different sizes.

This makes brass | harder | more flexible | softer | than the pure metals.

(1 mark)

4.3.1.2 Relative formula mass

Question 12 · continued

6 (b) Iron chloride has the formula $FeCl_3$

Relative atomic masses (A_r): Cl = 35.5; Fe = 56.

6 (b) (i) Calculate the relative formula mass (M_r) of iron chloride ($FeCl_3$).

.....

.....

.....

Relative formula mass (M_r) of iron chloride = ...

(2 marks)

6 (b) (ii) Calculate the percentage of iron in iron chloride ($FeCl_3$).

.....

.....

.....

Percentage of iron in iron chloride = ...%

(2 marks)

6

4.3.1.2 Relative formula mass

Question 13

June 2013 | CH1FP | Original Q7 | Legacy

7 Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

7 (a) Copper is now extracted from ores containing a low percentage of copper compounds.

Suggest **two** reasons why.

.....

.....

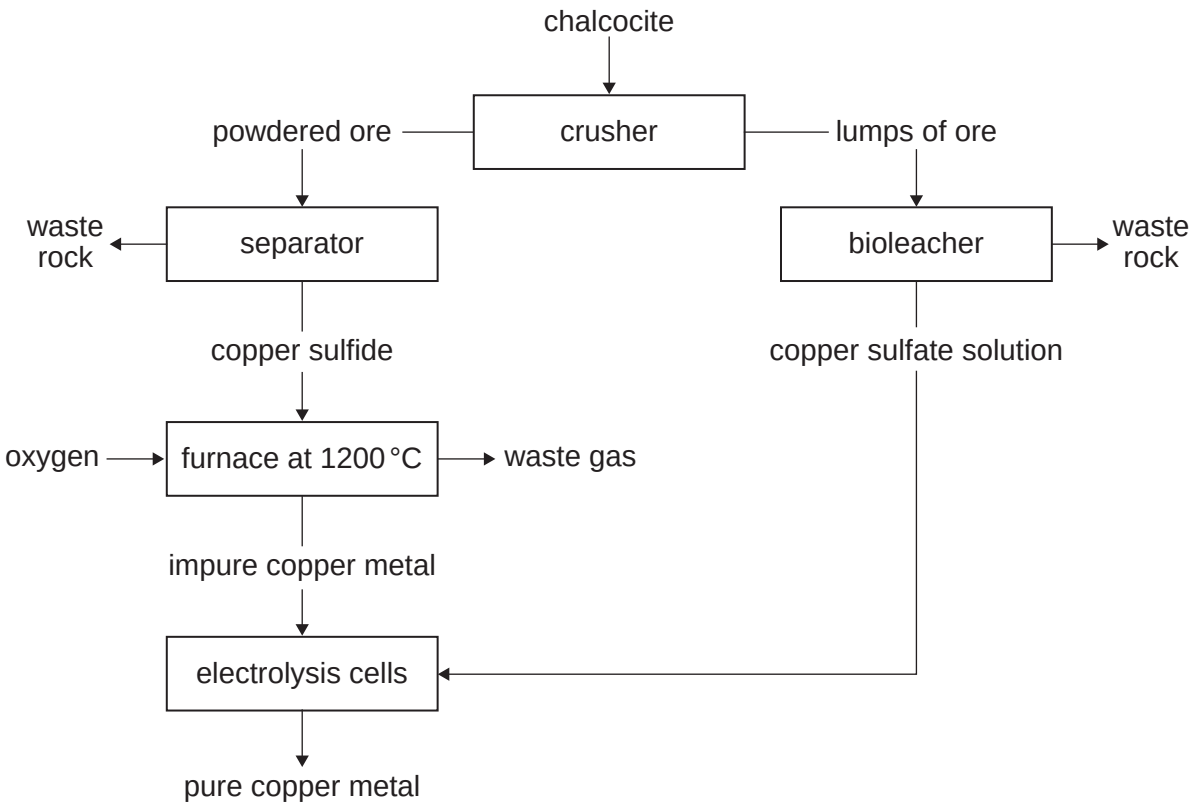
.....

.....

(2 marks)

7 (b) Chalcocite, an ore of copper, contains copper sulfide.

The flow diagram shows how copper metal is extracted from chalcocite.



4.3.1.2 Relative formula mass

Question 13 · continued

7 (b) (i) Suggest **one** reason why it is difficult to dispose of the waste rock.

.....

.....

(1 mark)

7 (b) (ii) The reaction in the furnace could cause environmental pollution.
Explain how.

.....

.....

.....

.....

(2 marks)

7 (b) (iii) The extraction of pure copper is expensive.
Give **one** reason why.

.....

.....

(1 mark)

7 (b) (iv) Pure copper is produced by electrolysis of copper sulfate solution.

Which electrode do the copper ions move towards?
Give a reason for your answer.

.....

.....

.....

.....

(2 marks)

7 (b) (v) Large areas of land are contaminated with copper compounds.
Phytomining can be used to remove these copper compounds from the land.

What is used in phytomining to remove copper compounds from the land?

.....

.....

(1 mark)

9

4.3.1.2 Relative formula mass

Question 14

June 2013 | CH2FP | Original Q1 | Legacy

1 This question is about lithium and sodium.

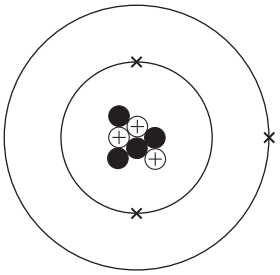
1 (a) Use the Chemistry Data Sheet to help you to answer this question.

In which group of the periodic table are lithium and sodium? Group ☐

(1 mark)

1 (b) A lithium atom can be represented as $^{7}_{3}Li$

The diagram represents the lithium atom.



1 (b) (i) Some particles in the nucleus have a positive charge.

What is the name of these particles? .....

(1 mark)

1 (b) (ii) Some particles in the nucleus have no charge.

What is the name of these particles? .....

(1 mark)

1 (b) (iii) Use the correct answer from the box to complete the sentence.

3	4	7

The mass number of this atom of lithium is ☐

(1 mark)

Question 1 continues on the next page

4.3.1.2 Relative formula mass

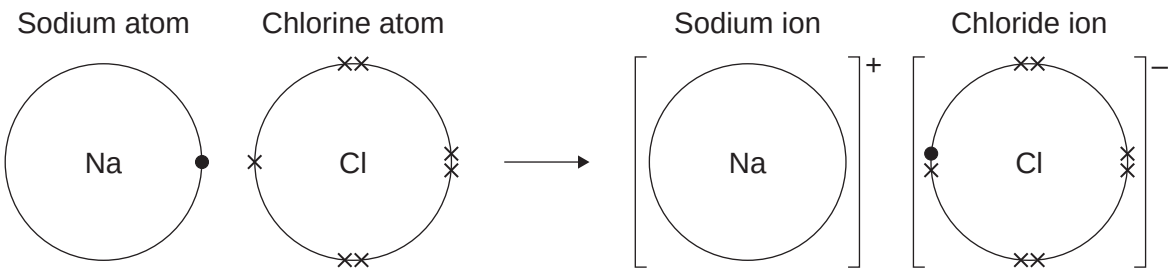
Question 14 · continued

1 (c) Sodium reacts with chlorine to produce sodium chloride.

sodium + chlorine ⟶ sodium chloride

The diagram shows how the reaction happens.

Only the outer electrons are shown.



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

1 (c) (i) A sodium atom changes into a sodium ion by [gaining / losing / sharing] an electron.

(1 mark)

1 (c) (ii) A sodium ion has [a negative / no / a positive] charge.

(1 mark)

1 (c) (iii) The ions in sodium chloride are held together by strong [covalent / electrostatic / magnetic] forces.

(1 mark)

4.3.1.2 Relative formula mass

Question 14 · continued

1 (d) Sodium chloride is an ionic compound.

Tick (✓) **two** properties of ionic compounds.

Property	Tick (✓)
Do **not** dissolve in water	
High melting points	
Low boiling points	
Strong bonds	

(2 marks)

1 (e) (i) The formula of sodium chloride is NaCl

Calculate the relative formula mass of sodium chloride.

Relative atomic masses: Na = 23; Cl = 35.5

.....

.....

Relative formula mass = ...

(1 mark)

1 (e) (ii) Draw a ring around the correct answer to complete the sentence.

The relative formula mass of a substance, in grams, is one [ion / isotope / mole] of the substance.

(1 mark)

1 (f) Nanoparticles of sodium chloride (salt) are used to flavour crisps.

What are nanoparticles?

.....

.....

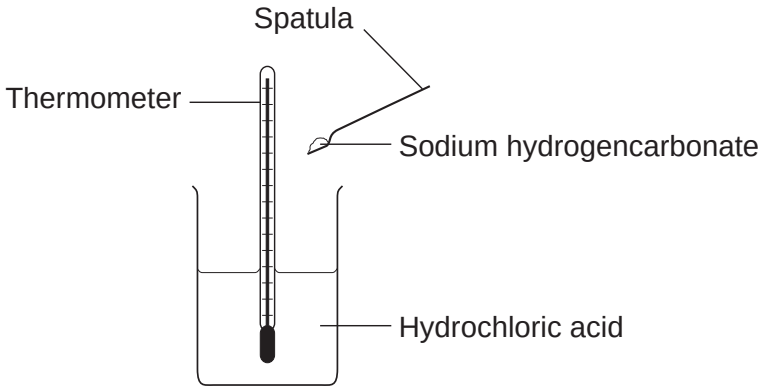
(1 mark)

12

4.3.1.2 Relative formula mass

Question 15

7 (a) Some students did an experiment to find the temperature change when hydrochloric acid reacts with sodium hydrogencarbonate.



The results are in the table.

Number of spatula measures of sodium hydrogencarbonate	Start temperature in °C	Final temperature in °C	Change in temperature in °C
2	20	16	4
4	20	14	6
6	19	11	8
8	20	10	10
10	19	9	10
12	20	10	10

4.3.1.2 Relative formula mass

Question 15 · continued

7 (a) (i) Describe, as fully as you can, the trends shown in the students' results.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

7 (a) (ii) State the type of energy transfer for this reaction.

.....

.....

(1 mark)

Question 7 continues on the next page

4.3.1.2 Relative formula mass

Question 15 · continued

7 (b) Sodium hydrogencarbonate is used as baking powder for making cakes.

When the cake mixture is baked the sodium hydrogencarbonate decomposes.

The equation for the reaction is:

$$2\,NaHCO_3(s) \xrightarrow{\text{Heat}} Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

7 (b) (i) The cake mixture rises when baked.



Use the equation to suggest why.

.....

.....

(1 mark)

7 (b) (ii) The same reaction can be reversed to produce sodium hydrogencarbonate from sodium carbonate.

$$Na_2CO_3 + H_2O + CO_2 \longrightarrow 2\,NaHCO_3$$

Do the reactants need to be heated?

Give a reason for your answer.

.....

.....

(1 mark)

4.3.1.2 Relative formula mass

Question 15 · continued

7 (c) (i) Calculate the relative formula mass of sodium hydrogencarbonate ($NaHCO_3$).

Relative atomic masses (A_r): H=1; C=12; O=16; Na=23

.....

.....

.....

Relative formula mass (M_r) = ...

(2 marks)

7 (c) (ii) Calculate the percentage by mass of carbon in sodium hydrogencarbonate.

.....

.....

Percentage of carbon = ... %

(1 mark)

9

4.3.1.2 Relative formula mass

Question 16

June 2014 | CH1FP | Original Q2 | Legacy

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

Table 1 shows the percentage of four gases in the atmosphere of Mars today and the atmosphere of Earth today.

Table 1

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

2 (a) Which **one** of the gases in **Table 1** is a noble gas?

[1 mark]

.....

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

2 (b) (i) Noble gases are in Group

0

1

7

[1 mark]

2 (b) (ii) Noble gases are

slightly reactive.

unreactive.

very reactive.

[1 mark]

4.3.1.2 Relative formula mass

Question 16 · continued

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

2 (c) (i) Calculate the decrease in the percentage of carbon dioxide in the Earth's atmosphere.
[1 mark]

.....

.....

Decrease in percentage = ...%

2 (c) (ii) Give **two** reasons for this decrease.
[2 marks]

.....

.....

.....

.....

6

4.3.1.2 Relative formula mass

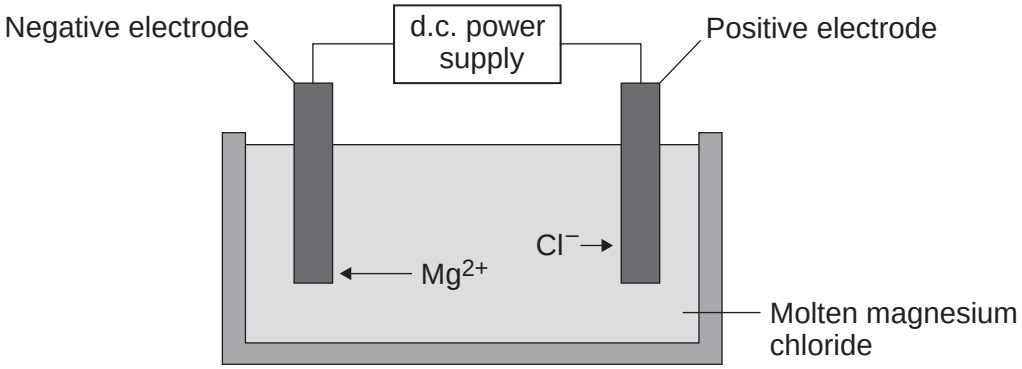
Question 17

June 2014 | CH2FP | Original Q5 | Legacy

5 Some students investigated reactions to produce magnesium.

5 (a) The students used electrolysis to produce magnesium from magnesium chloride, as shown in **Figure 7**.

Figure 7



5 (a) (i) Magnesium chloride contains magnesium ions and chloride ions.

Why does solid magnesium chloride **not** conduct electricity?

[1 mark]

.....

.....

5 (a) (ii) One of the products of the electrolysis of molten magnesium chloride is magnesium.

Name the other product.

[1 mark]

.....

5 (a) (iii) Why do magnesium ions (Mg^{2+}) move to the negative electrode?

[1 mark]

.....

.....

4.3.1.2 Relative formula mass

Question 17 · continued

5 (a) (iv) At the negative electrode, the magnesium ions (Mg^{2+}) gain electrons to become magnesium atoms.

How many electrons does each magnesium ion gain?

[1 mark]

.....

5 (b) The students did the experiment four times and weighed the magnesium produced.

Table 1 shows their results.

Table 1

Experiment	Mass of magnesium produced in grams
1	1.13
2	0.63
3	1.11
4	1.09

5 (b) (i) There is an anomalous result.

Suggest **one** possible reason for the anomalous result.

[1 mark]

.....

.....

5 (b) (ii) Calculate the mean mass of magnesium produced, taking account of the anomalous result.

[2 marks]

.....

.....

.....

Mean mass = ... g

4.3.1.2 Relative formula mass

Question 17 · continued

5 (c) The formula of magnesium chloride is $MgCl_2$

The relative formula mass of magnesium chloride is 95.

The relative atomic mass of magnesium is 24.

5 (c) (i) Use the equation to calculate the percentage mass of magnesium in magnesium chloride.

$$\text{Percentage mass of magnesium} = \frac{\text{mass of magnesium}}{\text{mass of magnesium chloride}} \times 100\%$$

[2 marks]

.....

.....

.....

Percentage mass of magnesium in magnesium chloride = ... %

5 (c) (ii) Draw a ring around the relative mass of chlorine in $MgCl_2$

[1 mark]

71 **95** **119**

4.3.1.2 Relative formula mass

Question 17 · continued

5 (d) Magnesium is also produced from the reaction of magnesium oxide with silicon.

5 (d) (i) The equation for the reaction is:

$$2\ MgO(s) + Si(s) \rightleftharpoons SiO_2(s) + 2\ Mg(s)$$

What is the meaning of this symbol $\rightleftharpoons$?

Draw a ring around the correct answer.

[1 mark]

neutralisation reaction **precipitation reaction** **reversible reaction**

5 (d) (ii) The forward reaction is endothermic.

Draw a ring around the correct answer to complete the sentence.

[1 mark]

In an endothermic reaction the temperature of the surroundings

decreases.

increases.

stays the same.

12

4.3.1.2 Relative formula mass

Question 18

June 2015 | CH1FP | Original Q2 | Legacy

2 Copper is a transition metal.

2 (a) (i) Where is copper in the periodic table?

[1 mark]

Tick (✓) **one** box.

in the central block ☐

in Group 1 ☐

in the noble gas group ☐

2 (a) (ii) What is a property of copper?

[1 mark]

Tick (✓) **one** box.

breaks easily ☐

conducts electricity ☐

does not conduct heat ☐

4.3.1.2 Relative formula mass

Question 18 · continued

2 (b) Copper ores are quarried by digging large holes in the ground, as shown in **Figure 3**.

Figure 3



Give **two** reasons why quarrying is bad for the environment.

[2 marks]

.....

.....

.....

.....

Question 2 continues on the next page

4.3.1.2 Relative formula mass

Question 18 · continued

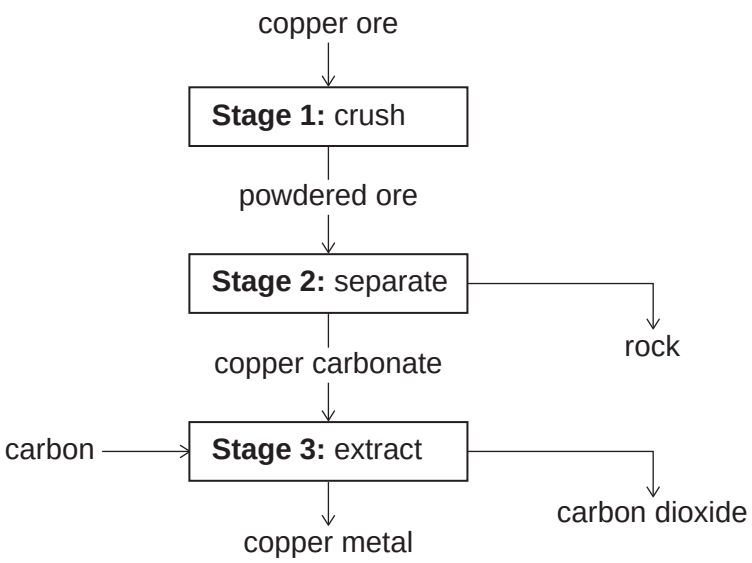
2 (c) Some copper ores contain only 2% copper.

Most of the ore is rock that is not needed.

In one ore, the main compound is copper carbonate ($CuCO_3$).

Figure 4 shows the stages used in the extraction of copper from this ore.

Figure 4



2 (c) (i) Why is **Stage 2** important?

[1 mark]

.....

.....

4.3.1.2 Relative formula mass

Question 18 · continued

2 (c) (ii) The equation for the reaction in **Stage 3** is:

$$2\,CuCO_3 + C \longrightarrow 2\,Cu + 3\,CO_2$$

From the symbol equation a company calculated that 247 tonnes of copper carbonate are needed to produce 127 tonnes of copper and 132 tonnes of carbon dioxide are released.

Calculate the mass of carbon needed to make 127 tonnes of copper.

[2 marks]

copper carbonate	+	carbon	⟶	copper	+	carbon dioxide
247 tonnes		..... tonnes		127 tonnes		132 tonnes

.....

.....

2 (c) (iii) Suggest **one** reason why it is important for the company to calculate the mass of reactants in **Stage 3**.

[1 mark]

.....

.....

8

4.3.1.2 Relative formula mass

Question 19

June 2015 | CH1FP | Original Q4 | Legacy

4 Polymers and fuels can be produced from crude oil and from plants.

4 (a) There are many types of polymer. Each polymer has different properties.

4 (a) (i) Poly(chloroethene) is a polymer produced from crude oil.

Why is poly(chloroethene) used for water pipes?

[2 marks]

Tick (✓) **two** boxes.

- The polymer is not biodegradable. ☐
- The polymer is made from crude oil. ☐
- The polymer decomposes when heated. ☐
- The polymer is waterproof. ☐
- The polymer does not conduct electricity. ☐

4 (a) (ii) Some shopping bags are made from a biopolymer.

Biopolymers are produced from plants.

Suggest **one** advantage of using a biopolymer.

[1 mark]

.....

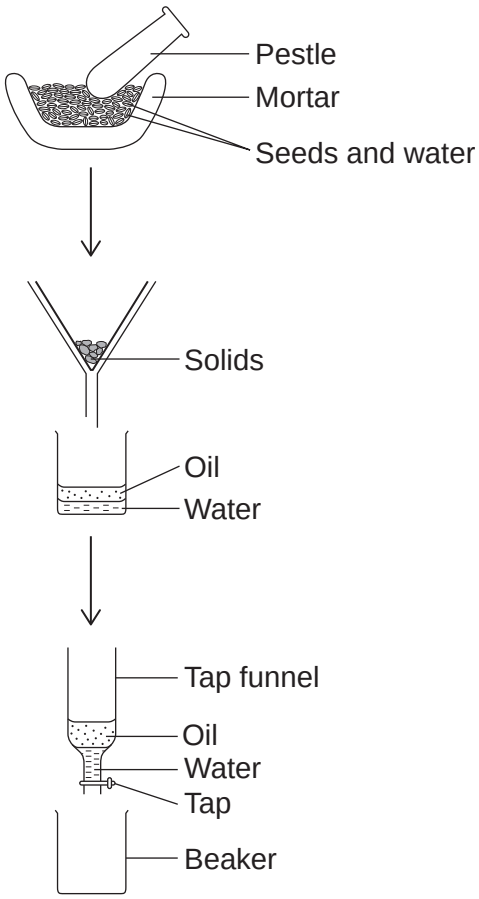
.....

4.3.1.2 Relative formula mass

Question 19 · continued

4 (b) Some plants have seeds that contain vegetable oils.
The flow diagram in **Figure 6** shows how the oil can be extracted.

Figure 6



4 (b) (i) Use the correct word from the box to complete each sentence.

[2 marks]

burning	**crushing**	**distilling**	**filtering**

Oil is released from the seeds by..... .

Solids are removed from the oil and water by ..... .

4 (b) (ii) Describe how the tap funnel can be used to separate the oil from the water.

[2 marks]

.....

.....

.....

.....

4.3.1.2 Relative formula mass

Question 19 · continued

4 (c) Vegetable oils are used as foods and fuels.

4 (c) (i) Why are vegetable oils important foods and fuels?

[1 mark]

Tick (✓) **one** box.

They are used as emulsifiers. ☐

They have high boiling points. ☐

They provide a lot of energy. ☐

4 (c) (ii) Burning fossil fuels made from crude oil increases the overall percentage of carbon dioxide in the atmosphere.

Burning biofuels made from vegetable oil does **not** increase the overall percentage of carbon dioxide in the atmosphere.

Explain why.

[2 marks]

.....

.....

.....

.....

10

4.3.1.2 Relative formula mass

Question 20

June 2015 | CH2FP | Original Q1 | Legacy

1 This question is about carbon and gases in the air.

1 (a) Carbon atoms have protons, neutrons and electrons.

Complete **Table 1** by writing the relative mass of a neutron and an electron.

[2 marks]

Table 1

Name of particle	Relative mass
proton	1
neutron	
electron	

1 (b) What is the total number of protons and neutrons in an atom called?

[1 mark]

Tick (✓) **one** box.

The atomic number ☐

The mass number ☐

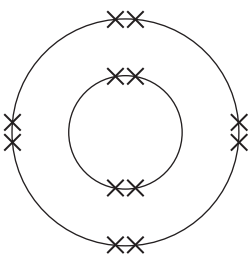
One mole of the atom ☐

1 (c) An atom of carbon has six electrons.

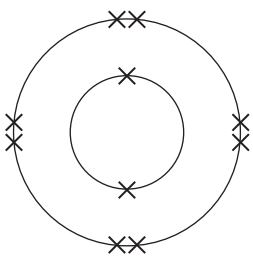
Which structure, **A**, **B** or **C**, represents the electronic structure of the carbon atom?

[1 mark]

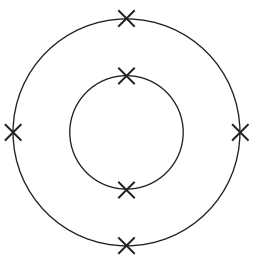
Structure A



Structure B



Structure C



The carbon atom is structure ☐.

4.3.1.2 Relative formula mass

Question 20 · continued June 2015 | CH2FP | Original Q1 | Legacy

1 (d) Carbon reacts with oxygen to produce carbon dioxide (CO_2).

1 (d) (i) How many different elements are in one molecule of carbon dioxide?

[1 mark]

.....

1 (d) (ii) What is the total number of atoms in one molecule of carbon dioxide?

[1 mark]

.....

1 (e) Sometimes carbon reacts with oxygen to produce carbon monoxide (CO).

1 (e) (i) Calculate the relative formula mass (M_r) of carbon monoxide.

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

[1 mark]

.....

.....

M_r of carbon monoxide = ...

1 (e) (ii) Calculate the percentage by mass of carbon in carbon monoxide.

[1 mark]

.....

.....

Percentage by mass of carbon in carbon monoxide = ...%

Question 1 continues on the next page

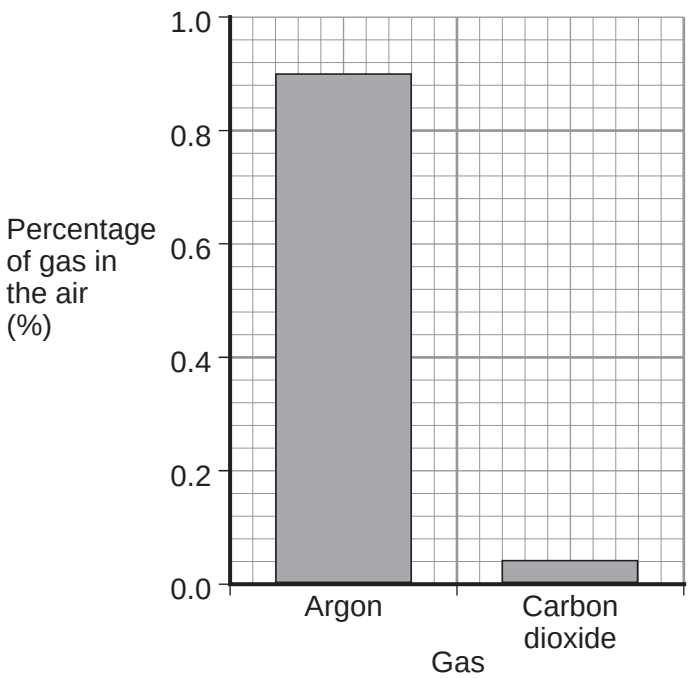
4.3.1.2 Relative formula mass

Question 20 · continued

1 (f) Carbon dioxide is one of the gases in the air.

1 (f) (i) **Figure 1** shows the percentage of argon and the percentage of carbon dioxide in the air.

Figure 1



What is the percentage of argon in the air?

[1 mark]

Percentage of argon = ... %

1 (f) (ii) An instrumental method is used to measure the amount of carbon dioxide in the air.

Give **one** reason for using an instrumental method.

[1 mark]

.....

.....

10

4.3.1.2 Relative formula mass

Question 21

June 2015 | CH2FP | Original Q3 | Legacy

3 Lead iodide is an insoluble salt.

3 (a) What type of substance is lead iodide?

[1 mark]

Tick (✓) **one** box.

An element ☐

A mixture ☐

A compound ☐

3 (b) A student produced lead iodide by a precipitation reaction.

Use the correct answers from the box to complete the word equation.

[2 marks]

lead bromide	**lead nitrate**	**potassium bromide**	**potassium iodide**

..... + ... ⟶ lead iodide + potassium nitrate

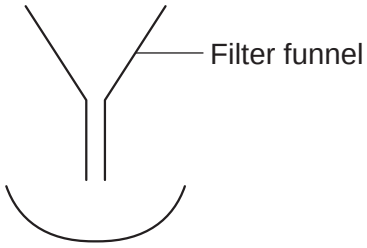
4.3.1.2 Relative formula mass

Question 21 · continued

3 (c) The student wanted to separate the precipitate of lead iodide from the solution by using filtration.

The student used the apparatus shown in **Figure 3**.

Figure 3



Explain why the apparatus in **Figure 3** would **not** separate the lead iodide from the mixture.

[2 marks]

.....

.....

.....

.....

3 (d) The student expected to get 5 g of lead iodide but only got 3 g.

3 (d) (i) The student did this calculation.

$\frac{3}{5} \times 100$

Use the correct answer from the box to complete the sentence.

[1 mark]

mass of one mole	**percentage yield**	**relative formula mass**

The student calculated the ..... .

3 (d) (ii) Give **one** reason why the mass the student got was less than expected.

[1 mark]

.....

.....

7

4.3.1.2 Relative formula mass

Question 22

June 2016 | CH1FP | Original Q3 | Legacy

3 Metals are extracted from ores in the Earth's crust.

3 (a) Why is copper used in the manufacture of computers?

[1 mark]

Tick (✓) **one** box.

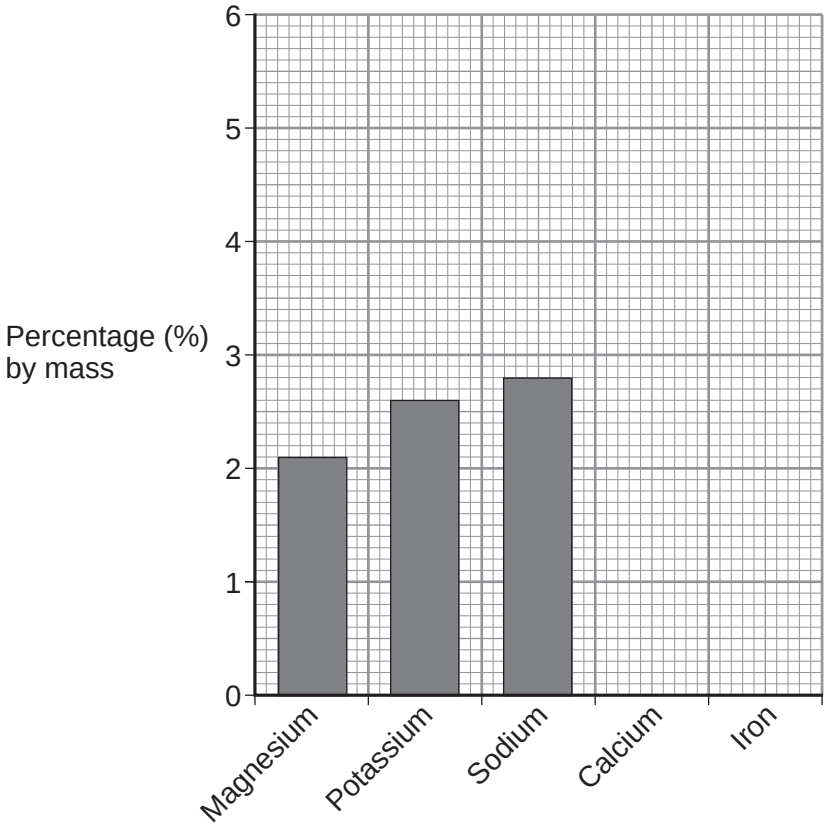
Because it has a high density. ☐

Because it does not react with water. ☐

Because it is a good conductor of electricity. ☐

3 (b) **Figure 6** shows the percentage (%) by mass of some metals in the Earth's crust.

Figure 6



4.3.1.2 Relative formula mass

Question 22 · continued

3 (b) (i) What is the percentage by mass of magnesium in the Earth's crust?

[1 mark]

_____ %

3 (b) (ii) On **Figure 6** draw the bars for:

- calcium at 3.6% by mass
- iron at 5.0% by mass.

[2 marks]

3 (c) An ore of zinc contains zinc carbonate.

The equation for the reaction when zinc carbonate is heated is:

$$\underset{\text{zinc carbonate}}{ZnCO_3} \longrightarrow \underset{\text{zinc oxide}}{ZnO} + \underset{\text{carbon dioxide}}{CO_2}$$

3 (c) (i) What is the name of this type of reaction?

[1 mark]

Tick (✓) **one** box.

corrosion ☐

decomposition ☐

electrolysis ☐

3 (c) (ii) Which substance in the equation is a gas at room temperature (20 °C)?

[1 mark]

Tick (✓) **one** box.

zinc carbonate ☐

zinc oxide ☐

carbon dioxide ☐

Question 3 continues on the next page

4.3.1.2 Relative formula mass

Question 22 · continued

3 (c) (iii) Complete **Table 1** to show the number of atoms of carbon and oxygen in the formula of zinc carbonate.

[2 marks]

Table 1

Element	Number of atoms in the formula $ZnCO_3$
zinc, Zn	1
carbon, C	
oxygen, O	

3 (c) (iv) When 125 g zinc carbonate is heated, 81 g zinc oxide is produced.

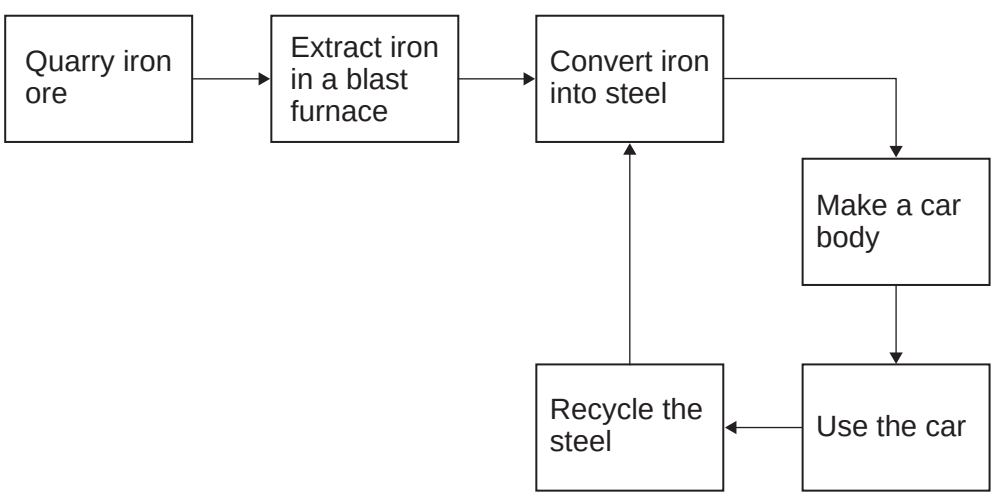
Calculate the mass of carbon dioxide produced.

[1 mark]

Mass of carbon dioxide = _____ g

3 (d) **Figure 7** shows a simple life cycle of a car body.

Figure 7



4.3.1.2 Relative formula mass

Question 22 · continued

3 (d) (i) What is **one** reason why iron from the blast furnace is converted into steel?

[1 mark]

Tick (✓) **one** box.

To make the iron pure. ☐

To make the iron more brittle. ☐

To make alloys for specific uses. ☐

3 (d) (ii) Apart from cost, give **three different** reasons why steel should be recycled.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

13

4.3.1.2 Relative formula mass

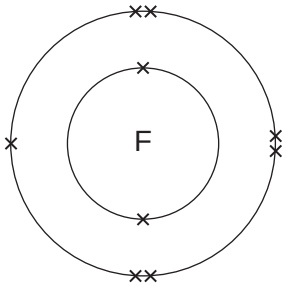
Question 23

June 2016 | CH2FP | Original Q1 | Legacy

1 This question is about fluorine.

1 (a) **Figure 1** shows the arrangement of electrons in a fluorine atom.

Figure 1



1 (a) (i) In which group of the periodic table is fluorine?

[1 mark]

Group _____

1 (a) (ii) Complete **Table 1** to show the particles in an atom and their relative masses.

[2 marks]

Table 1

Name of particle	Relative mass
Proton	
Neutron	1
	Very small

1 (a) (iii) Use the correct answer from the box to complete the sentence.

[1 mark]

alkalis	**alloys**	**isotopes**

Atoms of fluorine with different numbers of neutrons are called _____ .

4.3.1.2 Relative formula mass

Question 23 · continued

1 (b) Sodium reacts with fluorine to produce sodium fluoride.

1 (b) (i) Complete the word equation for this reaction.

[1 mark]

sodium + _____ ⟶ _____

1 (b) (ii) Complete the sentence.

[1 mark]

Substances in which atoms of two or more different elements are chemically combined are called _____ .

1 (b) (iii) The relative formula mass (M_r) of sodium fluoride is 42.

Use the correct answer from the box to complete the sentence.

[1 mark]

ion	mole	molecule

The relative formula mass (M_r), in grams, of sodium fluoride is one _____ of the substance.

Question 1 continues on the next page

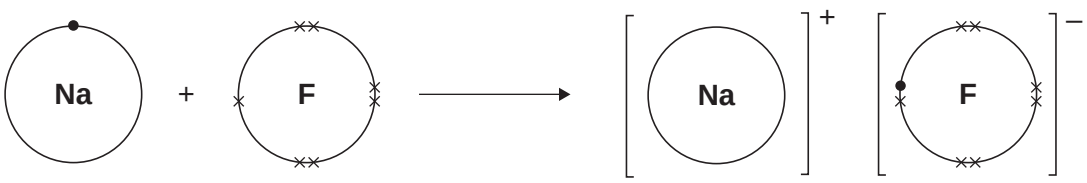
4.3.1.2 Relative formula mass

Question 23 · continued

1 (b) (iv) **Figure 2** shows what happens to the electrons in the outer shells when a sodium atom reacts with a fluorine atom.

The dots (•) and crosses (×) represent electrons.

Figure 2



Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when sodium reacts with fluorine to produce sodium fluoride.

[4 marks]

4.3.1.2 Relative formula mass

Question 23 · continued

1 (b) (v) Sodium fluoride is an ionic substance.

What are **two** properties of ionic substances?

[2 marks]

Tick (✓) **two** boxes.

- Dissolve in water ☐
- Gas at room temperature ☐
- High melting point ☐
- Low boiling point ☐

13

Turn over for the next question

4.3.1.2 Relative formula mass

Question 24

June 2016 | CH2FP | Original Q6 | Legacy

6 This question is about ammonia and fertilisers.

6 (a) Ammonia is produced by a reversible reaction.

The equation for the reaction is:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Complete the sentence.

[1 mark]

The forward reaction is exothermic, so the reverse reaction is _____ .

6 (b) Calculate the percentage by mass of nitrogen in ammonia (NH_3).
Relative atomic masses (A_r): H = 1; N = 14
You **must** show how you work out your answer.

[3 marks]

_____

_____

_____

_____

_____

_____

Percentage by mass of nitrogen = _____%

4.3.1.2 Relative formula mass

Question 24 · continued

6 (c) A neutral solution can be produced when ammonia reacts with an acid.

6 (c) (i) Give the pH of a neutral solution.

[1 mark]

pH _____

6 (c) (ii) Which of these ionic equations shows a neutralisation reaction?

[1 mark]

Tick (✓) **one** box.

$H^+ + OH^- \longrightarrow H_2O$ ☐

$NH_4^+ + OH^- \longrightarrow NH_4OH$ ☐

$H^+ + Cl^- \longrightarrow HCl$ ☐

$H^+ + H_2O \longrightarrow H_3O^+$ ☐

6 (c) (iii) Name the salt produced when ammonia reacts with hydrochloric acid.

[1 mark]

_____

Question 6 continues on the next page

Question 24 · continued

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

Farmers use ammonium nitrate as a fertiliser for crops.

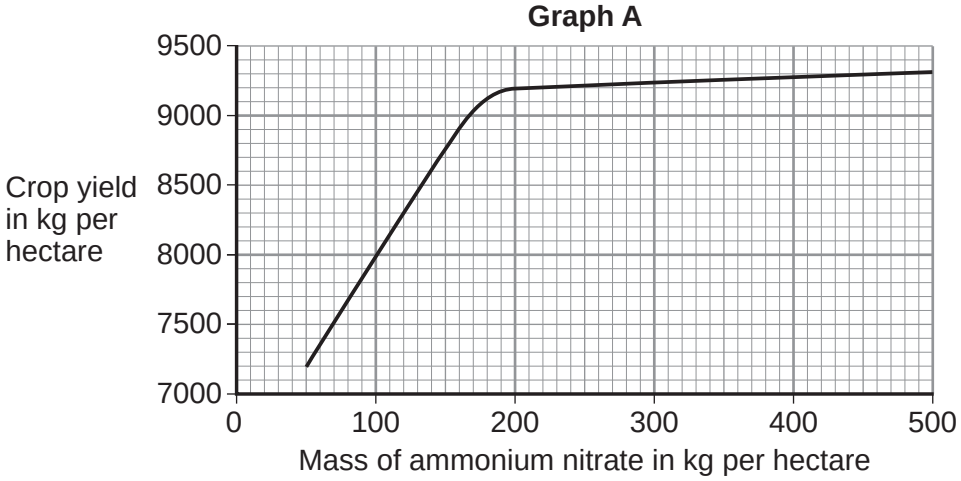
Rainwater dissolves ammonium nitrate in the soil.

Some of the dissolved ammonium nitrate runs off into rivers and lakes.

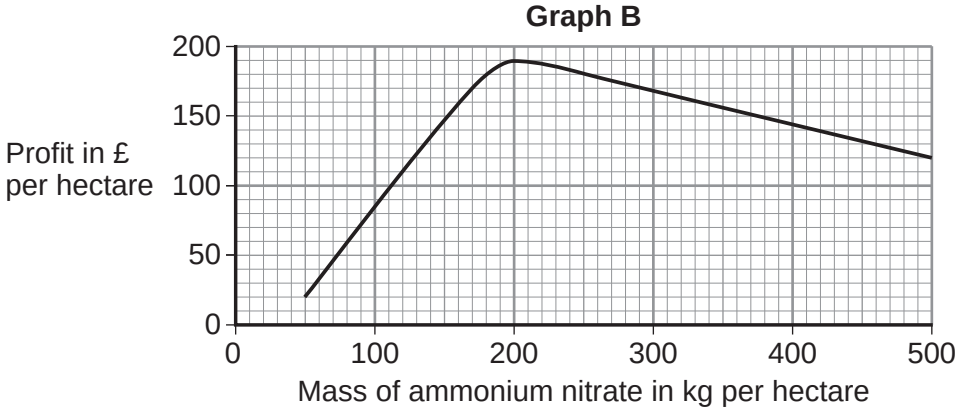
Figure 12 shows three graphs **A**, **B** and **C**. The graphs show information about the use of ammonium nitrate as a fertiliser. A hectare is a measurement of an area of land.

Figure 12

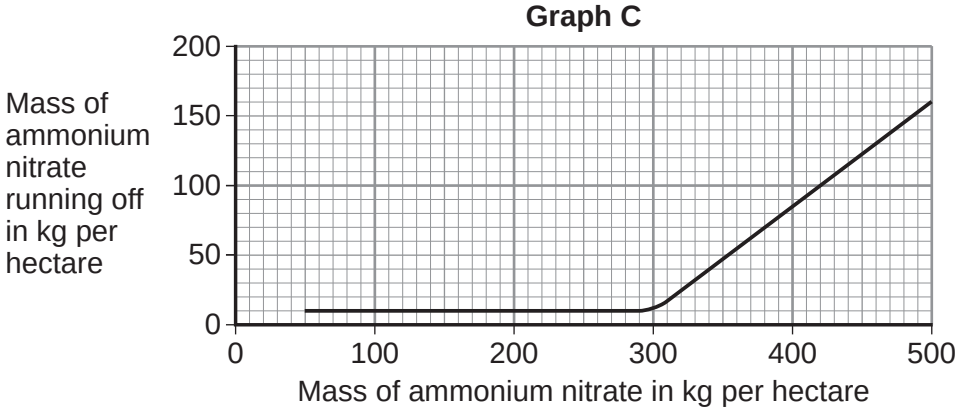
Graph A



Graph B



Graph C



4.3.1.2 Relative formula mass

Question 24 · continued

Suggest how much ammonium nitrate farmers should use per hectare.
Give reasons for your answer.
Use information from graphs **A**, **B** and **C**.

[6 marks]

Extra space

13

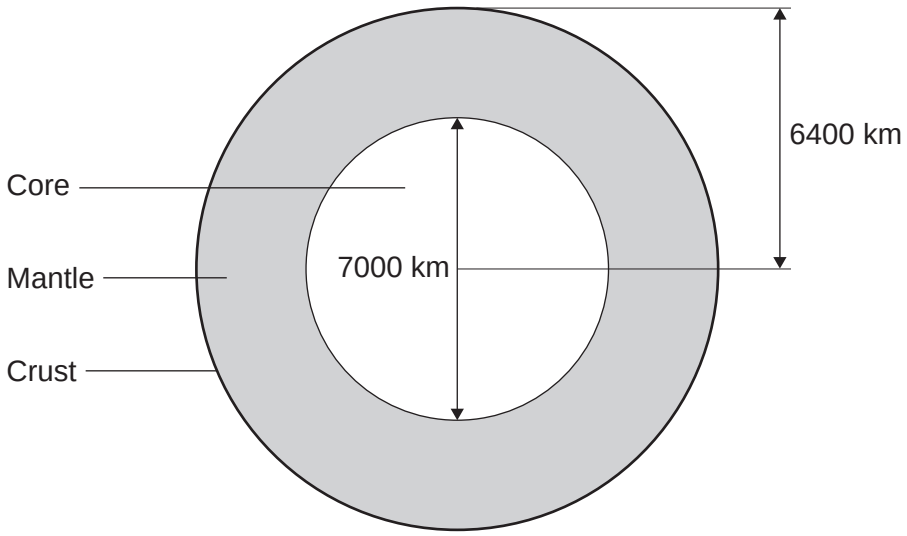
4.3.1.2 Relative formula mass

Question 25

June 2017 | CH1FP | Original Q5 | Legacy

5 (a) **Figure 4** shows the layered structure of the Earth.

Figure 4



5 (a) (i) The radius of the Earth is 6400 km.

Calculate the distance from the surface of the crust to the surface of the core.

[2 marks]

_____

_____

Distance = _____ km

5 (a) (ii) Use the correct answers from the box to complete the sentences.

Each word can be used only once.

[4 marks]

currents	**concentrations**	**distances**
plates	**processes**	**speeds**

Tectonic _____ move at _____ of a few centimetres per year.

This movement is caused by convection _____ within the Earth's mantle

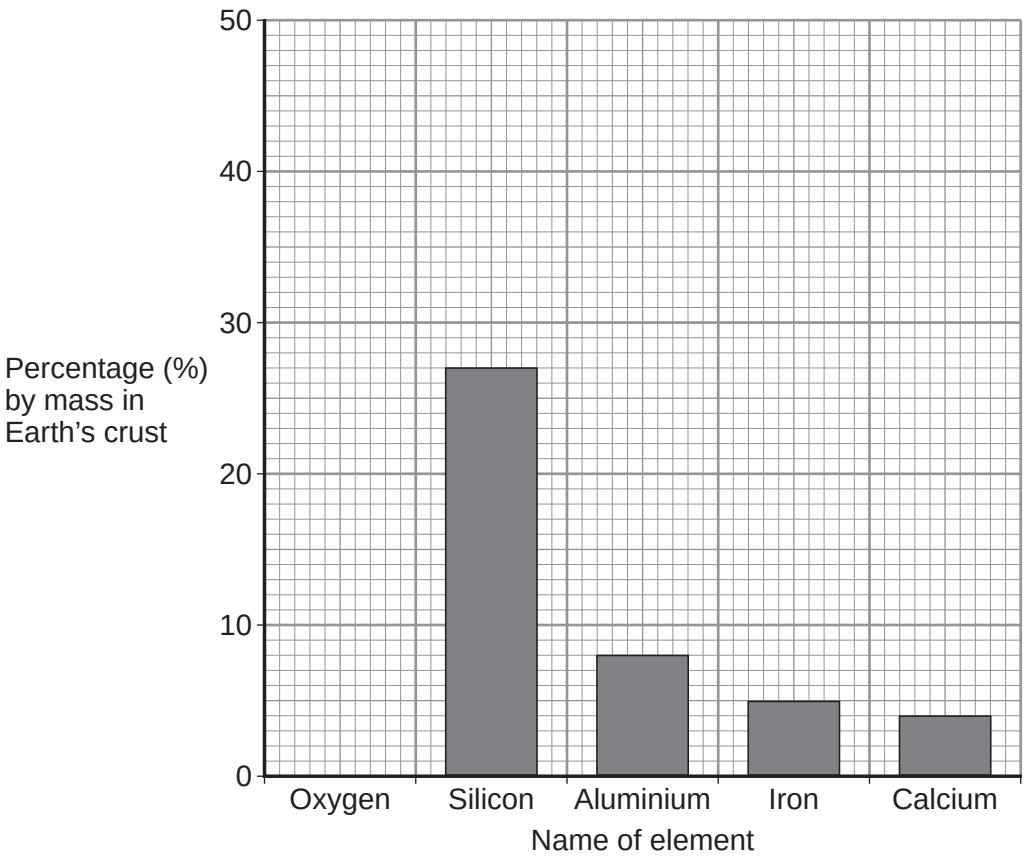
driven by heat released by natural radioactive _____ .

4.3.1.2 Relative formula mass

Question 25 · continued

5 (b) **Figure 5** shows the percentage by mass of some elements in the Earth's crust.

Figure 5



5 (b) (i) The percentage by mass of oxygen is 47%.

Draw the bar for oxygen on **Figure 5**.

[1 mark]

5 (b) (ii) Look at your completed bar chart.

What is the percentage by mass of all the other elements not shown on the chart in the Earth's crust?

[1 mark]

Tick (✓) **one** box.

1% ☐

9% ☐

20% ☐

4.3.1.2 Relative formula mass

Question 25 · continued

5 (b) (iii) There is about 0.007% by mass of copper in the Earth's crust.

Suggest why copper should be recycled.

[1 mark]

_____

_____

Question 5 continues on the next page

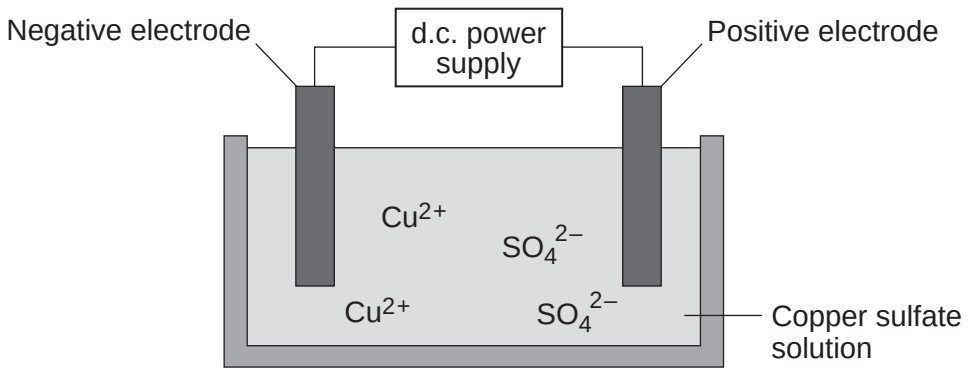
4.3.1.2 Relative formula mass

Question 25 · continued

5 (b) (iv) Bioleaching of low-grade copper ores produces a solution of copper sulfate.

Figure 6 shows apparatus used to obtain copper from copper sulfate solution.

Figure 6



What is the name of the process shown in **Figure 6**?

[1 mark]

Tick (✓) **one** box.

Combustion ☐

Cracking ☐

Electrolysis ☐

Hydration ☐

5 (b) (v) Explain why copper ions move towards the negative electrode in **Figure 6**.

[2 marks]

12

4.3.1.2 Relative formula mass

Question 26

June 2017 | CH2FP | Original Q4 | Legacy

4 This question is about sodium chloride.

4 (a) Calculate the relative formula mass (M_r) of sodium chloride (NaCl).

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

[1 mark]

_____

_____

Relative formula mass (M_r) = _____

4 (b) A student reacted hydrochloric acid and sodium hydroxide solution to produce sodium chloride and another product.

Use the correct answer from the box to complete the word equation for the reaction.

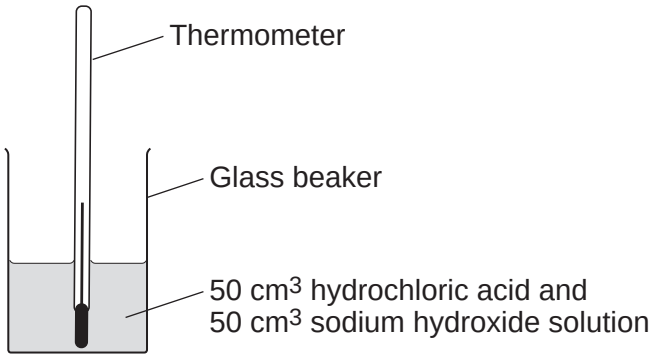
[1 mark]

chlorine	**hydrogen**	**oxygen**	**water**

hydrochloric acid + sodium hydroxide ⟶ sodium chloride + _____

4 (c) **Figure 7** shows the apparatus the student used to measure the temperature change in the reaction between hydrochloric acid and sodium hydroxide solution.

Figure 7



The student:

- measured 50 cm^3 hydrochloric acid into a glass beaker
- measured the temperature of the hydrochloric acid
- added 50 cm^3 of sodium hydroxide solution
- measured the highest temperature of the solution
- repeated the experiment with insulation around the glass beaker.

4.3.1.2 Relative formula mass

Question 26 · continued

4 (c) (i) Suggest **one** reason why the insulation around the glass beaker gives more accurate results.

[1 mark]

_____

_____

4 (c) (ii) The student did the investigation using the insulation three times.

Table 2 shows the results.

Table 2

Experiment number	Temperature of acid before reaction in °C	Highest temperature of solution in °C	Temperature change in °C
1	20	33	13
2	20	34	14
3	19	32	

Calculate the temperature change in **Experiment 3**.

Write your answer in **Table 2**.

[1 mark]

4 (c) (iii) How does **Table 2** show that the results are repeatable?

[1 mark]

_____

_____

4 (c) (iv) Complete the sentence.

[1 mark]

The temperature increase shows that the reaction between hydrochloric acid and sodium hydroxide is _____ .

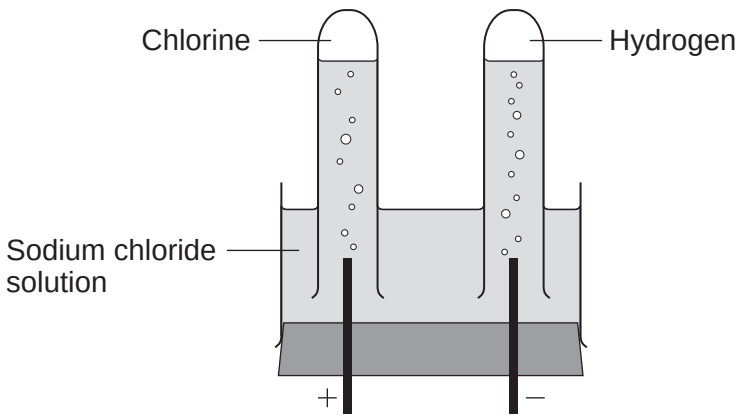
Question 4 continues on the next page

4.3.1.2 Relative formula mass

Question 26 · continued

4 (d) A student investigated the electrolysis of sodium chloride solution, as shown in **Figure 8**.

Figure 8



4 (d) (i) State, in terms of ions, why sodium chloride solution conducts electricity.

[1 mark]

_____

_____

4 (d) (ii) Chlorine is produced at the positive electrode.

Why are chloride ions attracted to the positive electrode?

[1 mark]

_____

_____

4 (d) (iii) When sodium chloride solution is electrolysed, sodium hydroxide is also produced.

What can be manufactured from sodium hydroxide?

[1 mark]

Tick (✓) **one** box.

Alloys ☐

Poly(ethene) ☐

Soap ☐

4.3.1.2 Relative formula mass

Question 26 · continued

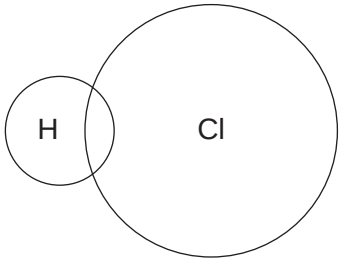
4 (d) (iv) The products chlorine and hydrogen react to form hydrogen chloride.

Hydrogen atoms have one electron in their outer shell. Chlorine atoms have seven electrons in their outer shell.

Complete **Figure 9** to show how the outer electrons are arranged in a molecule of hydrogen chloride (HCl).

[2 marks]

Figure 9



4 (d) (v) Which calculation shows the percentage of hydrogen in hydrogen chloride?

Relative atomic masses (A_r): H = 1; Cl = 35.5

Relative formula mass (M_r): HCl = 36.5

[1 mark]

Tick (✓) **one** box.

$\frac{35.5}{36.5} \times 100$ ☐

$\frac{1}{35.5} \times 100$ ☐

$\frac{1}{36.5} \times 100$ ☐

$\frac{1}{72.0} \times 100$ ☐

12

4.3.1.2 Relative formula mass

Question 27

June 2018 | 8462/1F | Original Q2

0 2 The halogens are elements in Group 7.

0 2 . 1 Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom.

[1 mark]

_____

0 2 . 2 Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide?

[1 mark]

Tick **one** box.

- Giant covalent ☐
- Ionic lattice ☐
- Metallic structure ☐
- Small molecule ☐

0 2 . 3 What is the formula for fluorine gas?

[1 mark]

Tick **one** box.

- F ☐
- F_2 ☐
- F^2 ☐
- 2F ☐

4.3.1.2 Relative formula mass

Question 27 · continued

A student mixes solutions of halogens with solutions of their salts.

Table 1 shows the student's observations.

Table 1

	Potassium chloride (colourless)	Potassium bromide (colourless)	Potassium iodide (colourless)
Chlorine (colourless)		Solution turns orange	Solution turns brown
Bromine (orange)	No change		Solution turns brown
Iodine (brown)	No change	No change	

0 2 . 4 Explain how the reactivity of the halogens changes going down Group 7.

Use the results in **Table 1**.

[3 marks]

Question 2 continues on the next page

4.3.1.2 Relative formula mass

Question 27 · continued June 2018 | 8462/1F | Original Q2

A company uses chlorine to produce titanium chloride from titanium dioxide.

0 2 . 5 What is the relative formula mass (M_r) of titanium dioxide, TiO_2?

Relative atomic masses (A_r): O = 16 Ti = 48

[1 mark]

Tick **one** box.

64 ☐

80 ☐

128 ☐

768 ☐

0 2 . 6 The company calculates that 500 g of titanium dioxide should produce 1.2 kg of titanium chloride.

However, the company finds that 500 g of titanium dioxide only produces 900 g of titanium chloride.

Calculate the percentage yield.

[2 marks]

Percentage yield = _____ %

9

4.3.1.2 Relative formula mass

Question 28

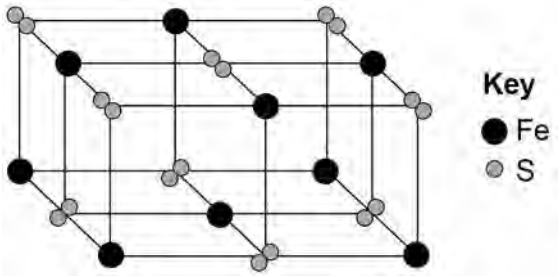
June 2018 | 8462/1F | Original Q9

0 9 This question is about metals and metal compounds.

0 9 . 1 Iron pyrites is an ionic compound.

Figure 12 shows a structure for iron pyrites.

Figure 12



Determine the formula of iron pyrites.

Use **Figure 12**.

[1 mark]

0 9 . 2 An atom of iron is represented as $^{56}_{26}Fe$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

0 9 . 3 Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.

[2 marks]

1 _____

_____

2 _____

_____

4.3.1.2 Relative formula mass

Question 28 · continued

Nickel is extracted from nickel oxide by reduction with carbon.

0 9 . 4 Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

0 9 . 5 An equation for the reaction is:

$$NiO + C \rightarrow Ni + CO$$

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

[3 marks]

Percentage atom economy = _____ %

11

4.3.1.2 Relative formula mass

Question 29

June 2018 | 8462/2F | Original Q9

0 9 Methylated spirit is a useful product made from a mixture of substances.

Table 6 shows the mass of the substances in a sample of methylated spirit.

Table 6

Substance	Mass in grams
Ethanol	265.5
Methanol	23.3
Pyridine	3.0
Methyl violet	1.5

0 9 . 1 What name is given to a useful product such as methylated spirit?

[1 mark]

_____

0 9 . 2 Calculate the percentage by mass of methanol in methylated spirit.

Use **Table 6**.

[2 marks]

_____

_____

_____

_____

Percentage = _____ %

Question 9 continues on the next page

4.3.1.2 Relative formula mass

Question 29 · continued

Methylated spirit contains ethanol and is available cheaply.

Methylated spirit also contains:

- pyridine which has a very unpleasant smell
- methyl violet which makes the mixture purple.

0 9 . 3 Suggest why pyridine and methyl violet are added to ethanol to make methylated spirit.

[1 mark]

0 9 . 4 Suggest **one** use of methylated spirit.

[1 mark]

0 9 . 5 Describe how ethanol is produced from sugar solution.

Give the name of this process.

[3 marks]

4.3.1.2 Relative formula mass

Question 29 · continued

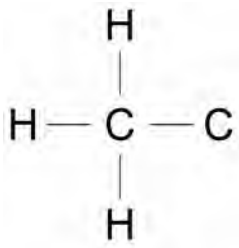
June 2018 | 8462/2F | Original Q9

0 9 . 6 **Figure 9** shows part of the displayed formula for ethanol.

Complete **Figure 9**.

[1 mark]

Figure 9



0 9 . 7 Name the gas produced when sodium is added to ethanol.

[1 mark]

0 9 . 8 Methanol is used to produce methanoic acid.

What type of substance reacts with methanol to produce methanoic acid?

[1 mark]

4.3.1.2 Relative formula mass

Question 30

June 2019 | 8462/1F | Original Q6

0 6 This question is about the extraction of metals.

0 6 . 1 Tungsten is a metal.

The symbol of tungsten is W

Tungsten is produced from tungsten oxide by reaction with hydrogen.

The equation for the reaction is:

$$WO_3 + 3H_2 \rightarrow W + 3H_2O$$

Calculate the percentage atom economy when tungsten is produced in this reaction.

Use the equation:

$$\text{percentage atom economy} = \frac{184}{(M_r\ WO_3) + (3 \times M_r\ H_2)} \times 100$$

Relative formula masses (M_r): $WO_3 = 232$ $H_2 = 2$

[2 marks]

Percentage atom economy = _____ %

4.3.1.2 Relative formula mass

Question 30 · continued

Aluminium is extracted from aluminium oxide.

0 6 . 2 38% of a rock sample is aluminium oxide.

Calculate the mass of aluminium oxide in 40 kg of the rock sample.

[2 marks]

Mass of aluminium oxide = _____ kg

0 6 . 3 The formula of aluminium oxide is Al_2O_3

Calculate the relative formula mass (M_r) of aluminium oxide.

Relative atomic masses (A_r): O = 16 Al = 27

[2 marks]

Relative formula mass (M_r) = _____

Question 6 continues on the next page

4.3.1.2 Relative formula mass

Question 30 · continued

0 6 . 4 60.0 kg of aluminium oxide produces a maximum of 31.8 kg of aluminium.

In an extraction process only 28.4 kg of aluminium is produced from 60.0 kg of aluminium oxide.

Calculate the percentage yield.

Give your answer to 3 significant figures.

Use the equation:

$$\text{percentage yield} = \frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$$

[3 marks]

Percentage yield = _____ %

0 6 . 5 Extracting metals by electrolysis is a very expensive process.

Explain why aluminium is extracted using electrolysis and not by reduction with carbon.

[2 marks]

11

4.3.1.2 Relative formula mass

Question 31

June 2019 | 8462/2F | Original Q3

0 3 Hydrogen is a raw material in the Haber process.

Hydrogen is produced from methane.

The word equation for the reaction is:

methane + steam ⇌ carbon monoxide + hydrogen

0 3 . 1 How can you tell that the reaction is reversible?

[1 mark]

0 3 . 2 The forward reaction is endothermic.

Name the type of energy change in the reverse reaction.

[1 mark]

0 3 . 3 A nickel catalyst is used in this reaction.

Why is a catalyst used in this reaction?

[2 marks]

Tick (✓) **two** boxes.

- To increase the temperature ☐
- To produce less carbon monoxide ☐
- To reduce costs ☐
- To use less energy ☐
- To use less methane ☐

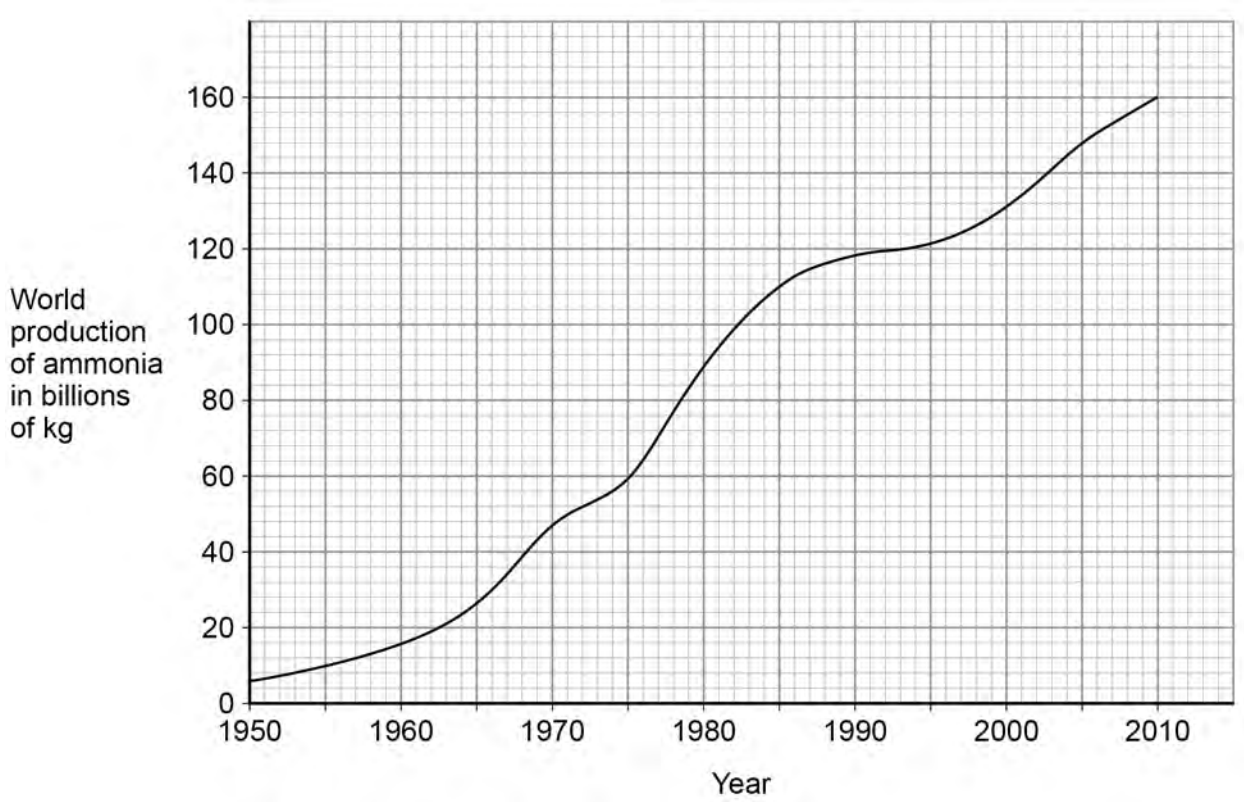
4.3.1.2 Relative formula mass

Question 31 · continued

0 3 . 4 The Haber process also uses nitrogen to produce ammonia.

Figure 1 shows how the world production of ammonia changed between 1950 and 2010.

Figure 1



Describe how the world production of ammonia changed between 1950 and 2010.

[2 marks]

4.3.1.2 Relative formula mass

Question 31 · continued

Most of the ammonia produced is used to make fertilisers.

0 3 . 5 Why did the world production of ammonia change between 1950 and 2010?

[2 marks]

Tick (✓) **two** boxes.

- The demand for food changed. ☐
- The demand for fuels changed. ☐
- The nitrogen percentage in air changed. ☐
- The number of cars changed. ☐
- The world population changed. ☐

Table 1 shows data about four fertilisers, **A**, **B**, **C** and **D**.

Table 1

Fertiliser	Percentage by mass of nitrogen (%)	Percentage by mass of phosphorus (%)	Percentage by mass of potassium (%)
A	35.0	0.0	0.0
B	21.2	0.0	0.0
C	21.2	23.5	0.0
D	0.0	0.0	52.3

4.3.1.2 Relative formula mass

Question 31 · continued

0 3 . 6 Which combination of fertilisers **A**, **B**, **C** and **D** provides **all** of the elements needed for an NPK fertiliser?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

- **A** and **C** ☐
- **A** and **D** ☐
- **B** and **C** ☐
- **C** and **D** ☐

0 3 . 7 Which fertiliser is **not** made using ammonia?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

- **A** ☐
- **B** ☐
- **C** ☐
- **D** ☐

10

4.3.1.2 Relative formula mass

Question 32

June 2019 | 8462/2F | Original Q9

0 9 This question is about lithium carbonate.

Lithium carbonate is used in medicines.

Figure 7 shows a tablet containing lithium carbonate.

Figure 7



0 9 . 1 Lithium carbonate contains lithium ions and carbonate ions.

A student tested the tablet for lithium ions and for carbonate ions.

The student used:

- a metal wire
- dilute hydrochloric acid
- limewater.

Plan an investigation to show the presence of lithium ions **and** of carbonate ions in the tablet.

You should include the results of the tests for the ions.

[6 marks]

4.3.1.2 Relative formula mass

Question 32 · continued

0 9 . 2 The tablet also contains other substances.

The substances in tablets are present in fixed amounts.

What name is given to mixtures like tablets?

[1 mark]

0 9 . 3 The tablet has a mass of 1.20 g and contains 700 mg of lithium carbonate.

Calculate the percentage by mass of lithium carbonate in this tablet.

[3 marks]

Percentage by mass of lithium carbonate = _____ %

10

4.3.1.2 Relative formula mass

Question 33

November 2020 | 8462/1F | Original Q1

0 1 This question is about the elements in Group 7 of the periodic table.

Table 1 shows the melting points and boiling points of some of the elements.

Table 1

Element	Melting point in °C	Boiling point in °C
Fluorine	–220	–188
Chlorine	–101	–35
Bromine	–7	59

0 1 . 1 What is the state of bromine at 100 °C?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

Gas ☐

Liquid ☐

Solid ☐

4.3.1.2 Relative formula mass

Question 33 · continued

0 1 . 2 What temperature does chlorine gas condense at to form a liquid?

Use **Table 1**.

[1 mark]

Temperature = _____ °C

0 1 . 3 Complete the sentences.

[2 marks]

Going down Group 7 the melting points _____.

This is because the size of the molecules increases so the

intermolecular forces _____.

Question 1 continues on the next page

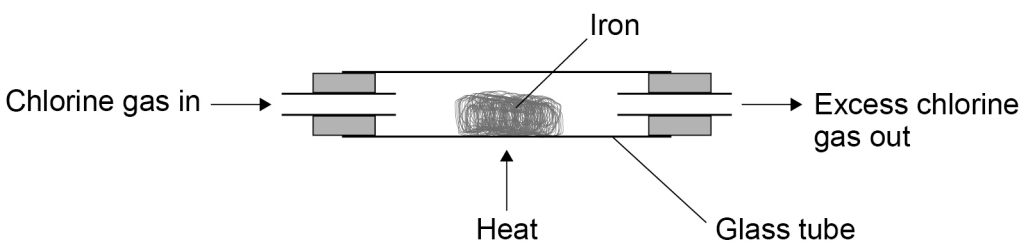
4.3.1.2 Relative formula mass

Question 33 · continued

A teacher investigated the reaction of iron with chlorine.

Figure 1 shows the apparatus used.

Figure 1



0 1 . 4 Why did the teacher do the investigation in a fume cupboard?

[1 mark]

Tick (✓) **one** box.

Chlorine gas is coloured. ☐

Chlorine gas is flammable. ☐

Chlorine gas is toxic. ☐

4.3.1.2 Relative formula mass

Question 33 · continued

0 1 . 5 The word equation for the reaction is:

iron + chlorine → iron chloride

Iron chloride is a solid.

The teacher weighed the glass tube and contents:

- before the reaction
- after the reaction.

What happened to the mass of the glass tube and contents during the reaction?

Give **one** reason for your answer.

[2 marks]

The mass of the glass tube and contents _____.

Reason _____

_____

Question 1 continues on the next page

4.3.1.2 Relative formula mass

Question 33 · continued

The teacher repeated the investigation with bromine gas and with iodine gas.

Table 2 shows the results.

Table 2

Element	Observation
Chlorine	Iron burns vigorously with an orange glow
Bromine	Iron burns with an orange glow
Iodine	Iron slowly turns darker

0 1 . 6 Fluorine is above chlorine in Group 7.

Predict what you would observe when fluorine gas reacts with iron.

Use **Table 2**.

[1 mark]

0 1 . 7 Balance the equation for the reaction between iron and bromine.

[1 mark]

$$2Fe + _____ Br_2 \rightarrow 2FeBr_3$$

0 1 . 8 Calculate the relative formula mass (M_r) of $FeBr_3$

Relative atomic masses (A_r): Fe = 56 Br = 80

[2 marks]

Relative formula mass (M_r) = _____

11

4.3.1.2 Relative formula mass

Question 34

November 2020 | 8462/1F | Original Q10

1 0 This question is about silver iodide.

Silver iodide is produced in the reaction between silver nitrate solution and sodium iodide solution.

The equation for the reaction is:

$$AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(aq)$$

1 0 . 1 A student investigated the law of conservation of mass.

This is the method used.

1. Pour silver nitrate solution into a beaker labelled **A**.
2. Pour sodium iodide solution into a beaker labelled **B**.
3. Measure the masses of both beakers and their contents.
4. Pour the solution from beaker **B** into beaker **A**.
5. Measure the masses of both beakers and their contents again.

Table 7 shows the student's results.

Table 7

	Mass before mixing in g	**Mass after mixing in g**
Beaker **A** and contents	78.26	108.22
Beaker **B** and contents	78.50	48.54

Explain how the results demonstrate the law of conservation of mass.

You should use data from **Table 7** in your answer.

[2 marks]

4.3.1.2 Relative formula mass

Question 34 · continued

1 0 . 2 Suggest how the student could separate the insoluble silver iodide from the mixture at the end of the reaction.

[1 mark]

The student purified the separated silver iodide.

This is the method used.

1. Rinse the silver iodide with distilled water.

2. Warm the silver iodide.

1 0 . 3 Suggest **one** impurity that was removed by rinsing with water.

[1 mark]

1 0 . 4 Suggest why the student warmed the silver iodide.

[1 mark]

Question 10 continues on the next page

4.3.1.2 Relative formula mass

Question 34 · continued

1 0 . 5 Calculate the percentage atom economy for the production of silver iodide in this reaction.

The equation for the reaction is:

$$AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(aq)$$

Give your answer to 3 significant figures.

Relative formula masses (M_r): $AgNO_3 = 170$ NaI = 150 AgI = 235 $NaNO_3 = 85$

[4 marks]

Percentage atom economy (3 significant figures) = _____ %

1 0 . 6 Give **one** reason why reactions with a high atom economy are used in industry.

[1 mark]

10

4.3.1.2 Relative formula mass

Question 35

November 2021 | 8462/1F | Original Q10

1 0 This question is about the extraction of metals.

Element **R** is extracted from its oxide by reduction with hydrogen.

The equation for the reaction is:

$$3\,H_2 + \mathbf{R}O_3 \rightarrow \mathbf{R} + 3\,H_2O$$

1 0 . 1 The sum of the relative formula masses (M_r) of the reactants ($3\,H_2$ + $\mathbf{R}O_3$) is 150

Calculate the relative atomic mass (A_r) of **R**.

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

[2 marks]

Relative atomic mass (A_r) of **R** = _____

1 0 . 2 Identify element **R**.

You should use:

- your answer to **question 10.1**
- the periodic table.

[1 mark]

Identity of **R** = _____

4.3.1.2 Relative formula mass

Question 35 · continued

1 0 . 3 Carbon is used to extract tin (Sn) from tin oxide (SnO_2).

The equation for the reaction is:

$$SnO_2 + C \rightarrow Sn + CO_2$$

Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12 O = 16 Sn = 119

[3 marks]

Percentage atom economy = _____ %

Question 10 continues on the next page

4.3.1.2 Relative formula mass

Question 35 · continued

November 2021 | 8462/1F | Original Q10

1 0 . 4 Tungsten (W) is a metal.

Tungsten is extracted from tungsten oxide (WO_3).

All other solid products from the extraction method must be separated from the tungsten.

Table 9 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 9

Method	Reactant	Relative cost of reactant	Products
1	Carbon	Low	Tungsten solid Carbon dioxide gas Tungsten carbide solid
2	Hydrogen	High	Tungsten solid Water vapour
3	Iron	Low	Tungsten solid Iron oxide solid

Evaluate the three possible methods for extracting tungsten from tungsten oxide.

[4 marks]

10

4.3.1.2 Relative formula mass

Question 36

November 2021 | 8462/2F | Original Q1

0 1 This question is about the Earth's atmosphere.

0 1 . 1 How long ago was the Earth formed?

[1 mark]

Tick (✓) **one** box.

- 4.6 billion years ago ☐
- 4.6 million years ago ☐
- 4.6 thousand years ago ☐

Table 1 shows the percentages of gases in the atmospheres of Mars and Earth today.

Table 1

Gas	Percentage of gas in atmosphere (%)	
	Mars	Earth
Carbon dioxide	95.97	0.04
Nitrogen	1.89	78.09
Oxygen	0.15	20.95
Other gases	1.99	**X**

0 1 . 2 Calculate the percentage **X** of other gases in the Earth's atmosphere.

Use **Table 1**.

[1 mark]

X = _____ %

4.3.1.2 Relative formula mass

Question 36 · continued

The atmosphere of the early Earth is thought to have been similar to the atmosphere of Mars today.

The percentages of nitrogen and of oxygen in the Earth's atmosphere today have changed from the percentages in the Earth's early atmosphere.

0 1 . 3 Draw **one** line from each gas to the change in the percentage of that gas.

Use **Table 1**.

[2 marks]

Gas	Change in percentage of gas
Nitrogen	Increased by about 4 times
	Increased by about 21%
Oxygen	Increased by about 40 times
	Increased by about 96%

0 1 . 4 The percentage of carbon dioxide in the Earth's early atmosphere decreased.

Which **two** processes caused this decrease?

[2 marks]

Tick (✓) **two** boxes.

- Carbon dioxide dissolving in sea water ☐
- Combustion of fossil fuels ☐
- Farming of animals ☐
- Formation of sedimentary rocks ☐
- Volcanoes releasing carbon dioxide ☐

4.3.1.2 Relative formula mass

Question 36 · continued

0 1 . 5 Photosynthesis also decreased the percentage of carbon dioxide in the Earth's early atmosphere.

Photosynthesis increased the percentage of another gas.

Complete the word equation for photosynthesis.

[2 marks]

_____ + water → glucose + _____

0 1 . 6 Complete the sentence.

[1 mark]

Scientists are not certain about the percentages of gases in the Earth's early atmosphere because there is a lack of _____.

9

4.3.1.2 Relative formula mass

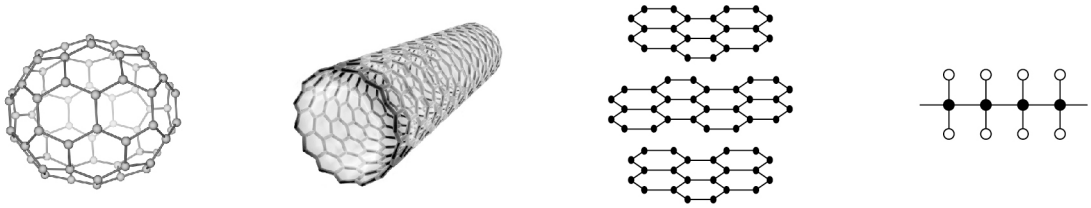
Question 37

June 2022 | 8462/1F | Original Q6

0 6 This question is about carbon and compounds of carbon.

Figure 9 shows diagrams that represent different structures.

Figure 9



A **B** **C** **D**

Use **Figure 9** to answer questions **06.1** and **06.2**.

0 6 . 1 Which diagram represents graphite?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 6 . 2 Which diagram represents poly(ethene)?

[1 mark]

Tick (✓) **one** box.

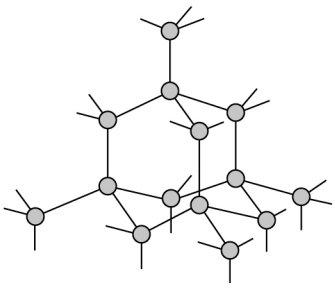
A ☐ **B** ☐ **C** ☐ **D** ☐

4.3.1.2 Relative formula mass

Question 37 · continued

Figure 10 represents the structure of diamond.

Figure 10



Key

Carbon atom

0 6 . 3 How many covalent bonds does each carbon atom form in diamond?

[1 mark]

0 6 . 4 Which is a property of diamond?

[1 mark]

Tick (✓) **one** box.

Conducts electricity ☐

Low melting point ☐

Very hard ☐

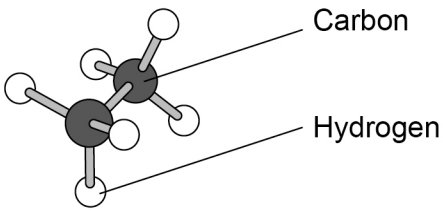
Question 6 continues on the next page

4.3.1.2 Relative formula mass

Question 37 · continued

0 6 . 5 **Figure 11** shows a model of a molecule.

Figure 11



Complete the molecular formula of the molecule.

[1 mark]

Molecular formula = C__ H__

Carbonic acid is a compound of carbon.

The formula of carbonic acid is H_2CO_3

0 6 . 6 Which ion is produced by carbonic acid in aqueous solution?

[1 mark]

Tick (✓) **one** box.

H^+ ☐ OH^- ☐ O^{2-} ☐

0 6 . 7 Calculate the relative formula mass (M_r) of carbonic acid (H_2CO_3).

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

[2 marks]

Relative formula mass (M_r) = _____

8

4.3.1.2 Relative formula mass

Question 38

June 2022 | 8462/1F | Original Q8

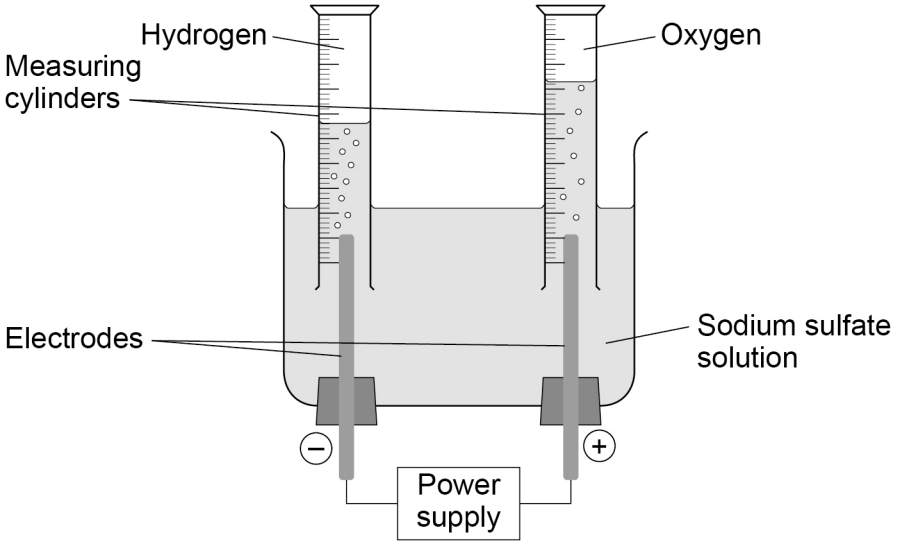
0 8 This question is about electrolysis.

Ionic compounds decompose when they are electrolysed.

A student electrolyses sodium sulfate solution.

Figure 13 shows the apparatus used.

Figure 13



0 8 . 1 Sodium sulfate solution contains:

- hydrogen ions
- hydroxide ions
- sodium ions
- sulfate ions.

Oxygen is produced at the positive electrode.

Which ions are discharged at the positive electrode to produce oxygen?

[1 mark]

Tick (✓) **one** box.

Hydrogen ions ☐

Hydroxide ions ☐

Sodium ions ☐

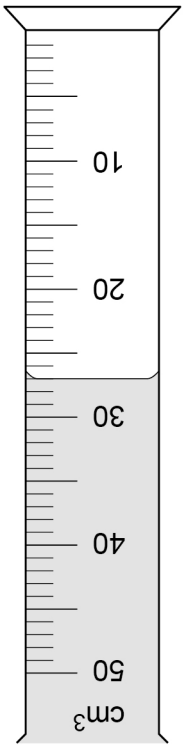
Sulfate ions ☐

4.3.1.2 Relative formula mass

Question 38 · continued

0 8 . 2 **Figure 14** shows one of the measuring cylinders during the electrolysis.

Figure 14



What is the volume of gas in the measuring cylinder?

[1 mark]

Volume of gas = _____ cm^3

0 8 . 3 Ionic compounds can be electrolysed when molten or dissolved in water.

Why can ionic compounds **not** be electrolysed when solid?

You should answer in terms of ions.

[1 mark]

_____

_____

4.3.1.2 Relative formula mass

Question 38 · continued

0 8 . 4 **Table 7** shows the products of electrolysis of two molten compounds.

Table 7

Molten compound	Product at negative electrode	Product at positive electrode
Potassium iodide	Potassium	_____
Zinc bromide	_____	Bromine

Complete **Table 7**.

[2 marks]

0 8 . 5 The electrolysis of molten sodium chloride is used to extract sodium metal.

Why is sodium metal extracted by electrolysis instead of by reduction with carbon?

[1 mark]

Tick (✓) **one** box.

Carbon conducts electricity. ☐

Carbon is less reactive than sodium. ☐

Carbon reduction uses more energy. ☐

0 8 . 6 What is the state symbol for molten sodium chloride?

[1 mark]

Tick (✓) **one** box.

(aq) ☐ (g) ☐ (l) ☐ (s) ☐

4.3.1.2 Relative formula mass

Question 38 · continued

0 8 . 7 Titanium can be produced from titanium oxide by electrolysis.

The equation for the reaction is:

$$TiO_2 \rightarrow Ti + O_2$$

Calculate the percentage atom economy for the production of titanium from titanium oxide by electrolysis.

Use the equation:

$$\text{Percentage atom economy} = \frac{\text{Relative atomic mass of desired product}}{\text{Relative formula mass of reactant}} \times 100$$

Relative atomic mass (A_r): Ti = 48

Relative formula mass (M_r): TiO_2 = 80

[2 marks]

Percentage atom economy = _____ %

9

4.3.1.2 Relative formula mass

Question 39

June 2022 | 8462/2F | Original Q3

0 3 This question is about the Earth's atmosphere.

Table 5 shows:

- the estimated percentages of gases in the Earth's early atmosphere
- the percentages of gases in the Earth's atmosphere today.

Table 5

Gas	Estimated percentage (%) in the Earth's early atmosphere	Percentage (%) in the Earth's atmosphere today
Nitrogen	1.8	**X**
Oxygen	0.2	20.95
Carbon dioxide	96.0	0.04
Other gases	2.0	0.92

0 3 . 1 Calculate value **X** in **Table 5**.

[1 mark]

X = _____ %

0 3 . 2 Which **two** other gases may have been in the Earth's early atmosphere?

[2 marks]

Tick (✓) **two** boxes.

- Ammonia ☐
- Coal ☐
- Limestone ☐
- Methane ☐
- Poly(ethene) ☐

4.3.1.2 Relative formula mass

Question 39 · continued

Algae and plants increased the percentage of oxygen in the Earth's atmosphere.

The same process in algae and plants decreased the percentage of carbon dioxide in the Earth's atmosphere.

0 3 . 3 Which process in algae and plants increased the percentage of oxygen in the Earth's atmosphere?

[1 mark]

Tick (✓) **one** box.

- Fermentation ☐
- Photosynthesis ☐
- Rusting ☐
- Sedimentation ☐

0 3 . 4 Which **two** other processes decreased the percentage of carbon dioxide in the Earth's atmosphere?

[2 marks]

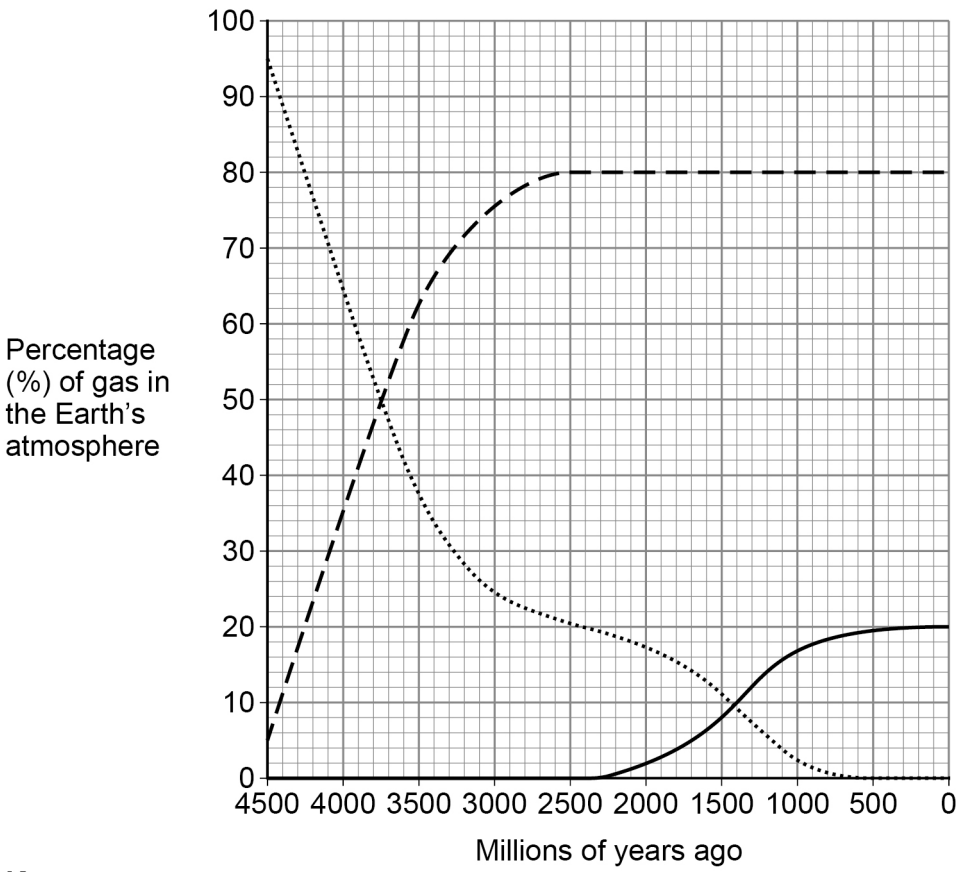
Tick (✓) **two** boxes.

- Burning fossil fuels ☐
- Dissolving carbon dioxide in oceans ☐
- Eruption of volcanoes ☐
- Evolution of animals ☐
- Formation of sedimentary rocks ☐

Question 39 · continued

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

Figure 3



0 3 . 5 When was the percentage of oxygen in the Earth's atmosphere 8%?

Use **Figure 3**.

[1 mark]

_____ millions of years ago

0 3 . 6 When did the percentage of nitrogen in the Earth's atmosphere become constant?

Use **Figure 3**.

[1 mark]

_____ millions of years ago

4.3.1.2 Relative formula mass

Question 39 · continued June 2022 | 8462/2F | Original Q3

0 3 . 7 Crude oil was formed from an ancient biomass as the Earth's atmosphere evolved.

What did this ancient biomass mainly consist of?

[1 mark]

Tick (✓) **one** box.

- Limestone ☐
- Plankton ☐
- Sand ☐

0 3 . 8 Most of the percentages of the gases in **Figure 3** are estimated values.

Why have scientists used estimated values for the percentages of the gases in **Figure 3**?

[1 mark]

_____

_____

10

4.3.1.2 Relative formula mass

Question 40

June 2023 | 8462/1F | Original Q4

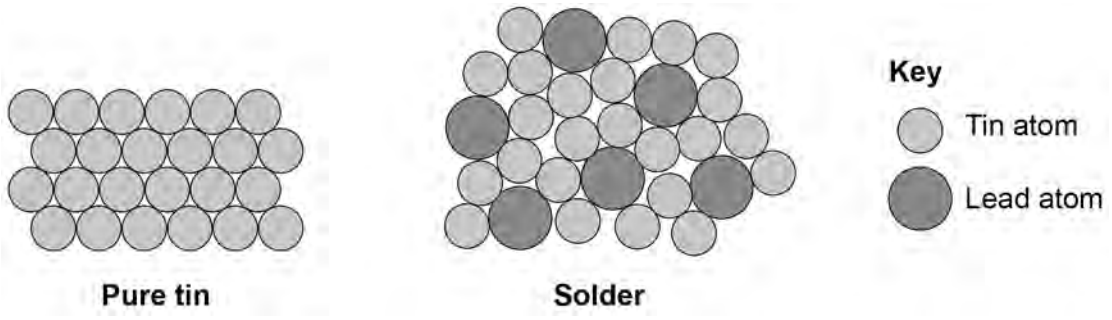
0 4 This question is about alloys.

Solders are alloys of tin and lead.

Different solders have different percentages of tin and lead.

Figure 4 shows the arrangement of atoms in pure tin and in a solder.

Figure 4



0 4 . 1 The solder in **Figure 4** has 6 lead atoms for every 24 tin atoms.

Determine the percentage of atoms that are lead atoms in the solder in **Figure 4**.

[3 marks]

Percentage of lead atoms = _____ %

0 4 . 2 Explain why solder is harder than pure tin.

Complete the sentences.

Use **Figure 4**.

[2 marks]

In solder the layers are distorted.

This is because the atoms of tin and lead have different _____.

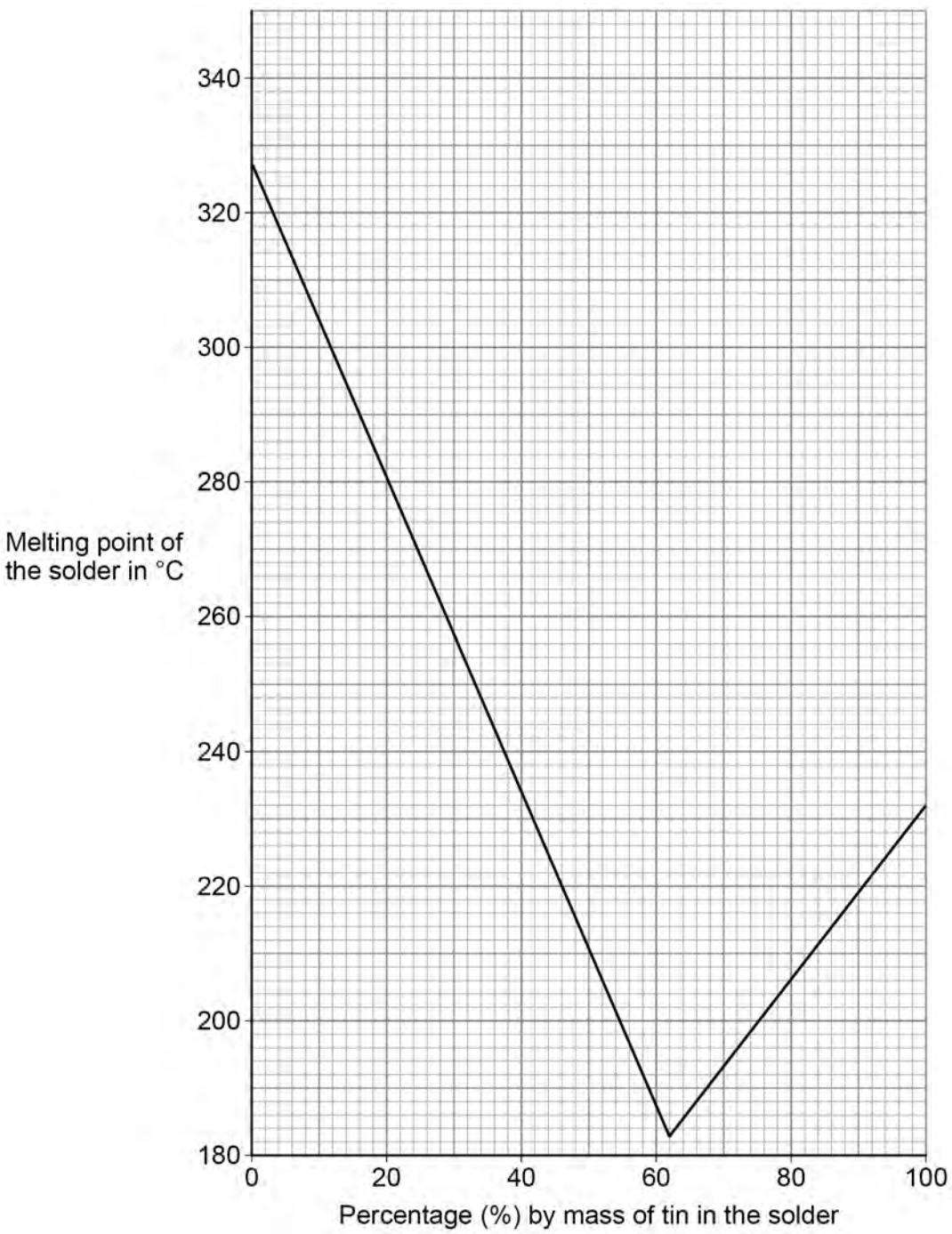
Therefore the layers cannot easily _____.

4.3.1.2 Relative formula mass

Question 40 · continued

Figure 5 shows how the melting point of the solder changes with the percentage by mass of tin in the solder.

Figure 5



4.3.1.2 Relative formula mass

Question 40 · continued

0 4 . 3 Describe what happens to the melting point of the solder as the percentage by mass of tin increases.

Use data from **Figure 5**.

[3 marks]

0 4 . 4 What is the melting point of pure tin?

Use **Figure 5**.

[1 mark]

Melting point of pure tin = _____ °C

0 4 . 5 What happens to the atoms in pure tin as the tin melts?

[1 mark]

Tick (✓) **one** box.

- The atoms gain energy and their arrangement becomes less ordered. ☐
- The atoms gain energy and their arrangement becomes more ordered. ☐
- The atoms lose energy and their arrangement becomes less ordered. ☐
- The atoms lose energy and their arrangement becomes more ordered. ☐

10

4.3.1.2 Relative formula mass

Question 41

June 2023 | 8462/1F | Original Q8

0 8 This question is about displacement reactions.

Iron is extracted from iron oxide by a displacement reaction with carbon.

0 8 . 1 Balance the equation for the reaction.

[2 marks]

$$Fe_2O_3 + 3\,C \rightarrow ____Fe + ____CO$$

0 8 . 2 Iron oxide is reduced in this reaction.

How does the equation show that iron oxide is reduced?

[1 mark]

0 8 . 3 Calculate the relative formula mass (M_r) of Fe_2O_3

Relative atomic masses (A_r): O = 16 Fe = 56

[2 marks]

M_r = _____

Question 8 continues on the next page

4.3.1.2 Relative formula mass

Question 41 · continued

0 8 . 4 Copper oxide reacts with hydrogen to produce copper.

The equation for the reaction is:

$$CuO + H_2 \rightarrow Cu + H_2O$$

Calculate the percentage atom economy for obtaining copper from this reaction.

Use the equation:

$$\text{Percentage atom economy} = \frac{A_r \text{ of Cu}}{M_r \text{ of } H_2 + M_r \text{ of CuO}} \times 100$$

Relative atomic mass (A_r): Cu = 63.5
Relative formula masses (M_r): H_2 = 2 CuO = 79.5

[2 marks]

Percentage atom economy = _____ %

A student investigated the reactivity of four different metals, **A**, **B**, **C** and **D**.

The student:

- added each metal to aqueous solutions of each of the metal sulfates
- observed whether a reaction took place.

0 8 . 5 Give **one** observation that would show a reaction took place.

[1 mark]

4.3.1.2 Relative formula mass

Question 41 · continued

0 8 . 6 **Table 4** shows the results.

Table 4

	Metal sulfate solution			
Metal	**A sulfate**	**B sulfate**	**C sulfate**	**D sulfate**
A	×	×	✓	×
B	✓	×	✓	×
C	×	×	×	×
D	✓	✓	✓	×

✓ shows that a displacement reaction took place.
× shows that a displacement reaction did not take place.

Write metals **A**, **B**, **C** and **D** in order of reactivity.

Give a reason for your order of reactivity.

[2 marks]

Most reactive _____

_____

_____

Least reactive _____

Reason _____

_____

10

4.3.1.2 Relative formula mass

Question 42

June 2023 | 8462/2F | Original Q5

0 5 This question is about greenhouse gases and climate change.

0 5 . 1 Which **two** gases are greenhouse gases?

[2 marks]

Tick (✓) **two** boxes.

- Argon ☐
- Carbon dioxide ☐
- Nitrogen ☐
- Methane ☐
- Oxygen ☐

0 5 . 2 Why are greenhouse gases essential for supporting life on Earth?

[1 mark]

_____

_____

The percentage of greenhouse gases in the Earth's atmosphere today is increasing.

Many scientists think that this increase is causing global climate change.

0 5 . 3 What is a cause of the greenhouse effect?

Complete the sentence.

[1 mark]

Greenhouse gases absorb long wavelength _____.

4.3.1.2 Relative formula mass

Question 42 · continued

0 5 . 4 Which **two** are potential effects of global climate change?

[2 marks]

Tick (✓) **two** boxes.

- Fewer droughts ☐
- Fewer storms ☐
- Higher sea levels ☐
- Less coastal flooding ☐
- Melting polar ice ☐

0 5 . 5 Water vapour is a greenhouse gas.

The percentage by mass of water vapour in the Earth's atmosphere is 0.25%.

Calculate the mass of water vapour in 350 kg of the Earth's atmosphere.

Give your answer in grams.

[3 marks]

Mass = _____ g

9

4.3.1.2 Relative formula mass

Question 43

June 2023 | 8462/2F | Original Q6

0 6 This question is about fuels.

The energy produced by burning fuels is used to generate electricity in power stations.

Table 5 shows information about three fuels used to generate electricity.

Table 5

	Fuel		
	Coal	**Oil**	**Natural gas**
State of fuel at room temperature	solid	liquid	gas
Transportation of fuel to power station	train	pipeline	pipeline
Percentage by mass of sulfur in fuel (%)	5	1	0.001
Relative quantity of solid particles produced when fuel is burned	high	medium	low

0 6 . 1 Explain why coal is usually transported to power stations by train and **not** by pipeline.

Use **Table 5**.

[2 marks]

4.3.1.2 Relative formula mass

Question 43 · continued

Sulfur dioxide and particulates are atmospheric pollutants produced when fuels are burned.

0 6 . 2 1 kg of each fuel in **Table 5** is burned.

Which fuel produces the **most** sulfur dioxide?

Give **one** reason for your choice.

[2 marks]

Fuel _____

Reason _____

_____

0 6 . 3 Give **one** problem caused by sulfur dioxide.

[1 mark]

_____

_____

0 6 . 4 Particulates are formed from solid particles.

1 kg of each fuel in **Table 5** is burned.

Which fuel produces the **least** particulates?

Give **one** reason for your choice.

[2 marks]

Fuel _____

Reason _____

_____

0 6 . 5 Give **one** problem caused by particulates.

[1 mark]

_____

_____

4.3.1.2 Relative formula mass

Question 43 · continued

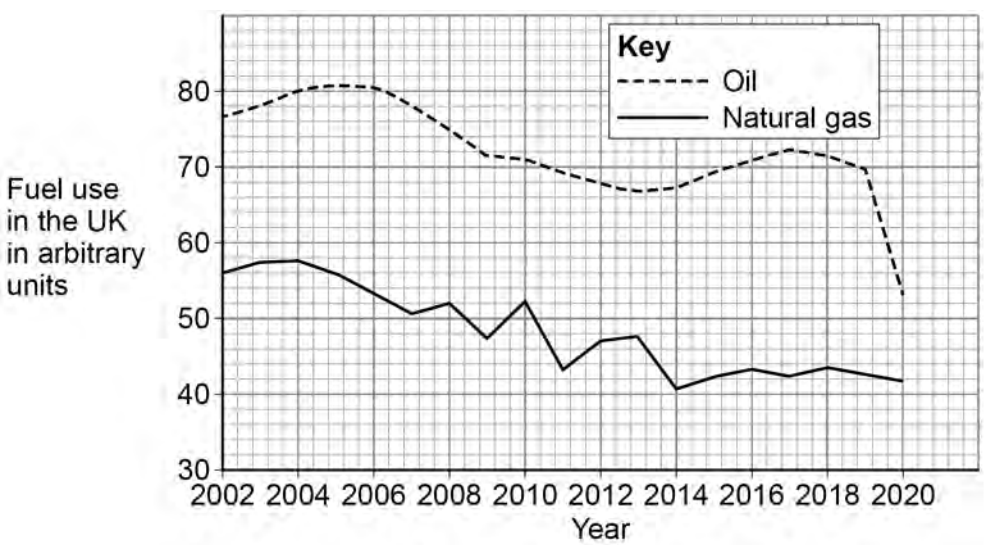
0 6 . 6 Complete the sentence.

[1 mark]

Solid particles are formed when fuels undergo incomplete _____.

0 6 . 7 **Figure 6** shows how the use of oil and of natural gas as fuels changed in the UK between 2002 and 2020.

Figure 6



Describe the trends shown in **Figure 6**.

[3 marks]

12

4.3.1.2 Relative formula mass

Question 44

June 2024 | 8462/1F | Original Q3

0 3 This question is about energy changes of reactions.

Zinc reacts with copper sulfate solution.

The word equation for the reaction is:

zinc + copper sulfate → zinc sulfate + copper

0 3 . 1 What type of reaction is the reaction between zinc and copper sulfate solution?

[1 mark]

Tick (✓) **one** box.

- Combustion ☐
- Decomposition ☐
- Displacement ☐

0 3 . 2 Calculate the percentage (%) by mass of copper in copper sulfate ($CuSO_4$).

Give your answer to 3 significant figures.

Relative atomic mass (A_r): Cu = 63.5

Relative formula mass (M_r): $CuSO_4$ = 159.5

[3 marks]

Percentage by mass (3 significant figures) = _____ %

4.3.1.2 Relative formula mass

Question 44 · continued

A student investigated the energy change in the reaction between zinc and copper sulfate solution.

This is the method used.

1. Measure 25 cm^3 of copper sulfate solution into a polystyrene cup.
2. Weigh 0.20 g of zinc powder.
3. Add the zinc powder to the copper sulfate solution.
4. Measure the highest temperature reached by the mixture.
5. Repeat steps 1 to 4 using different masses of zinc powder.

0 3 . 3 Control variables are used to make an investigation a fair test.

Which is a control variable in the investigation?

[1 mark]

Tick (✓) **one** box.

- Highest temperature reached by the mixture ☐
- Mass of zinc powder ☐
- Volume of copper sulfate solution ☐

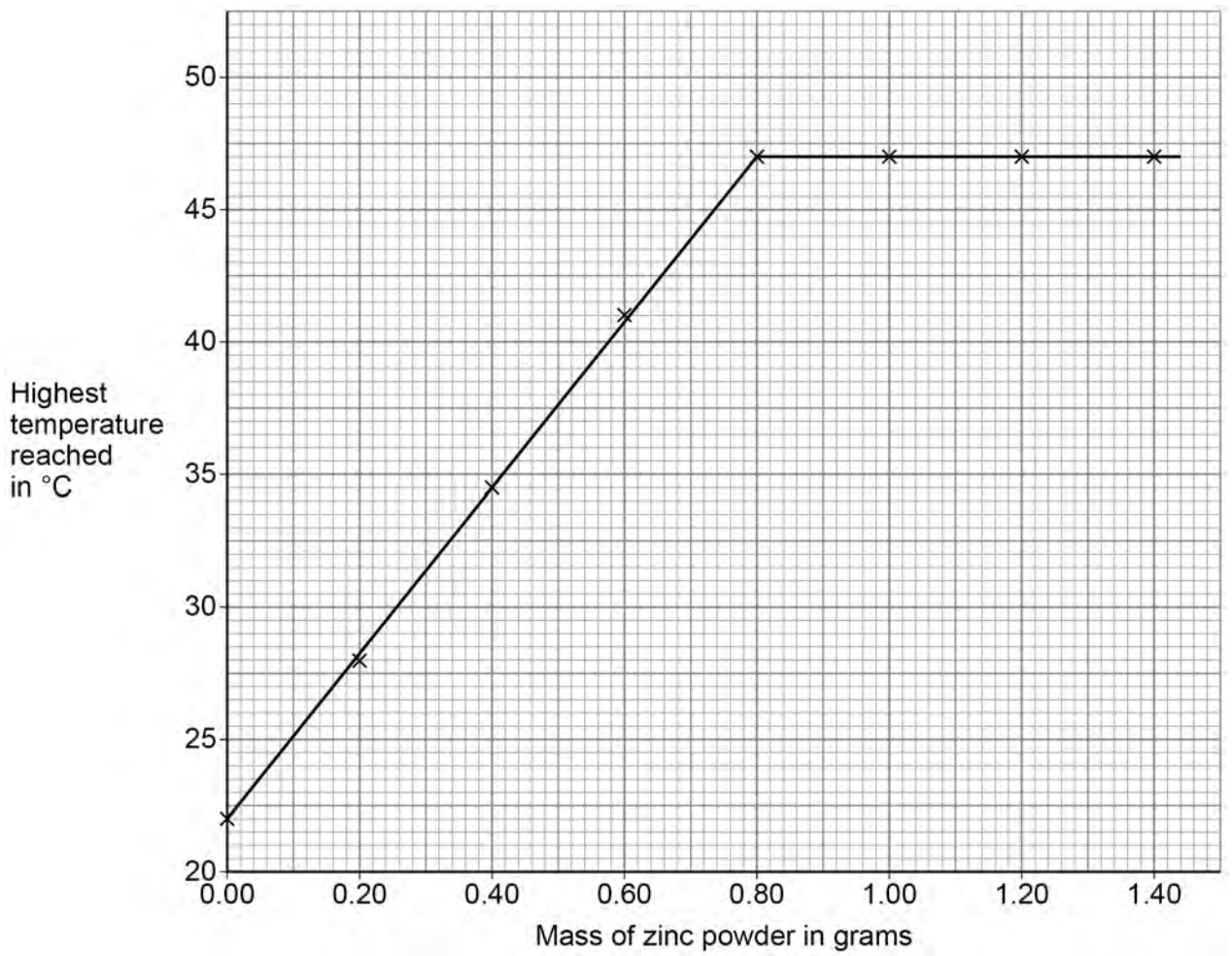
Question 3 continues on the next page

4.3.1.2 Relative formula mass

Question 44 · continued

Figure 6 shows the results.

Figure 6



0 3 . 4 What is the minimum mass of zinc powder needed to react with all the copper sulfate solution?

Use **Figure 6**.

[1 mark]

Minimum mass of zinc powder = _____ g

4.3.1.2 Relative formula mass

Question 44 · continued

0 3 . 5 What is the maximum temperature change in the reaction between zinc powder and 25 cm^3 of copper sulfate solution?

Use **Figure 6**.

[2 marks]

Maximum temperature change = _____ °C

0 3 . 6 25 cm^3 of copper sulfate solution contained 6.75 g of copper sulfate.

Calculate the concentration of the solution in g/dm^3.

You should:

- calculate the volume of the solution in dm^3 (1000 cm^3 = 1 dm^3)
- use the equation:

$$\text{concentration of solution in g/dm}^3 = \frac{\text{mass of copper sulfate in grams}}{\text{volume of solution in dm}^3}$$

[3 marks]

Volume of solution = _____ dm^3

Concentration of solution = _____ g/dm^3

Question 3 continues on the next page

4.3.1.2 Relative formula mass

Question 44 · continued

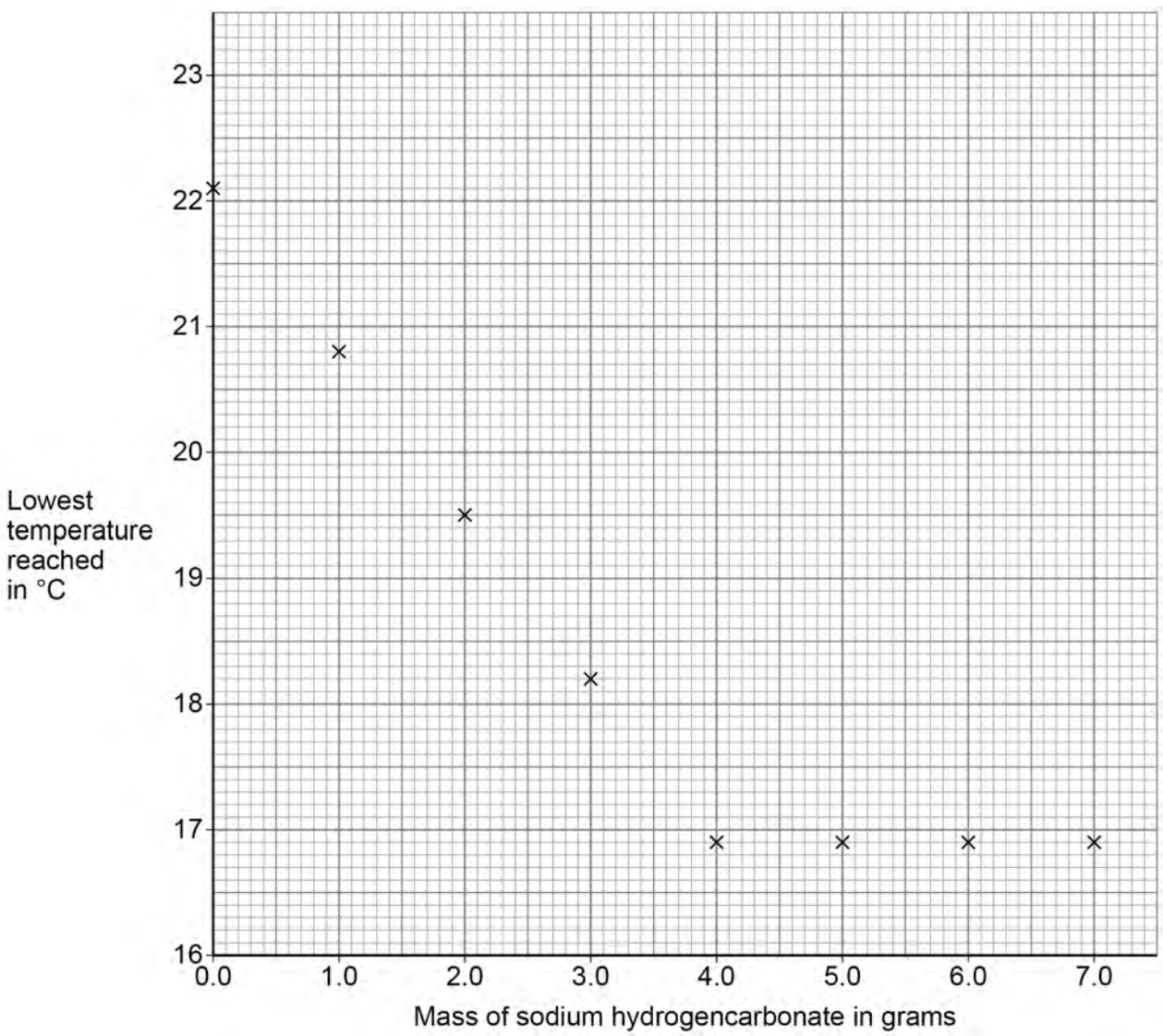
Another student investigated the energy change of the reaction between sodium hydrogencarbonate and hydrochloric acid.

This is the method used.

1. Measure 25 cm^3 of hydrochloric acid.
2. Weigh 1.0 g of sodium hydrogencarbonate.
3. Add the sample of sodium hydrogencarbonate to the hydrochloric acid.
4. Measure the lowest temperature reached by the mixture.
5. Repeat steps 1 to 4 using different masses of sodium hydrogencarbonate.

Figure 7 shows the results.

Figure 7



4.3.1.2 Relative formula mass

Question 44 · continued

0 3 . 7 Draw **two** straight lines of best fit on **Figure 7**.

The lines should cross.

[2 marks]

0 3 . 8 Which statement describes the energy change in the reaction shown in **Figure 7**?

[1 mark]

Tick (✓) **one** box.

Energy is **transferred to** the surroundings so the reaction is **endothermic**. ☐

Energy is **transferred to** the surroundings so the reaction is **exothermic**. ☐

Energy is **taken in from** the surroundings so the reaction is **endothermic**. ☐

Energy is **taken in from** the surroundings so the reaction is **exothermic**. ☐

14

4.3.1.2 Relative formula mass

Question 45

June 2024 | 8462/1F | Original Q6

0 6 This question is about electrolysis and the extraction of metals.

0 6 . 1 Why can some molten substances be electrolysed?

[1 mark]

Tick (✓) **one** box.

- Electrons can move through the molten substance to the electrodes. ☐
- Ions can move through the molten substance to the electrodes. ☐
- Protons can move through the molten substance to the electrodes. ☐

0 6 . 2 **Table 3** shows the products of the electrolysis of some molten compounds.

Complete **Table 3**.

[3 marks]

Table 3

Molten compound	Product at negative electrode	Product at positive electrode
Lead chloride	_____	Chlorine
Potassium iodide	Potassium	_____
_____	Zinc	Bromine

4.3.1.2 Relative formula mass

Question 45 · continued

Aluminium is extracted by electrolysing molten aluminium oxide.

0 6 . 3 Balance the equation for the reaction.

Choose numbers from the box.

[2 marks]

2	**3**	**4**	**5**

$$2Al_2O_3 \rightarrow __ Al + __ O_2$$

0 6 . 4 Calculate the relative formula mass (M_r) of aluminium oxide (Al_2O_3).

Relative atomic masses (A_r): O = 16 Al = 27

[2 marks]

Relative formula mass (M_r) = _____

Question 6 continues on the next page

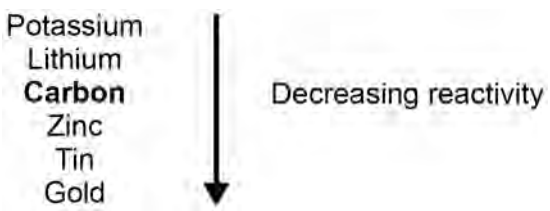
4.3.1.2 Relative formula mass

Question 45 · continued

0 6 . 5 **Figure 13** shows part of the reactivity series of metals.

The non-metal carbon has been included.

Figure 13



Metals can be extracted from their compounds by:

- electrolysis
- reduction with carbon.

Electrolysis is more expensive than reduction with carbon.

Predict one metal that would be extracted by each method.

Use Figure 13.

[2 marks]

Extracted by electrolysis _____

Extracted by carbon reduction _____

10

4.3.1.2 Relative formula mass

Question 46

June 2024 | 8462/2F | Original Q1

0 1 This question is about hydrocarbons.

A hydrocarbon has the formula C_6H_{14}

0 1 . 1 Name the **two** elements in a hydrocarbon.

[2 marks]

1 _____

2 _____

0 1 . 2 How many atoms are there in one molecule of C_6H_{14}?

[1 mark]

Tick (✓) **one** box.

2 ☐

6 ☐

14 ☐

20 ☐

C_6H_{14} is a member of a homologous series.

0 1 . 3 What is the general formula for the homologous series that contains C_6H_{14}?

[1 mark]

Tick (✓) **one** box.

C_nH_{2n-2} ☐

C_nH_{2n} ☐

C_nH_{2n+2} ☐

4.3.1.2 Relative formula mass

Question 46 · continued

0 1 . 4 Which homologous series has C_6H_{14} as a member?

[1 mark]

Tick (✓) **one** box.

Alcohols ☐

Alkanes ☐

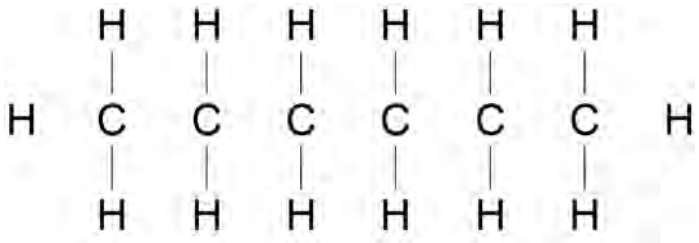
Alkenes ☐

Carboxylic acids ☐

0 1 . 5 Complete **Figure 1** to show the displayed structural formula of C_6H_{14}

[1 mark]

Figure 1



0 1 . 6 Petrol contains C_6H_{14}

Petrol is burned in car engines.

What general name is used to describe petrol when petrol is burned to release energy?

[1 mark]

_____

Question 1 continues on the next page

4.3.1.2 Relative formula mass

Question 46 · continued

0 1 . 7 Atmospheric pollutants are formed when C_6H_{14} undergoes incomplete combustion.

Complete the sentences.

Choose answers from the box.

[2 marks]

ammonia	**carbon monoxide**	**coal**
soot	**sulfur**	**sulfur dioxide**

The solid atmospheric pollutant formed during incomplete combustion of C_6H_{14} is

_____ .

The gaseous atmospheric pollutant formed during incomplete combustion of C_6H_{14} is

_____ .

0 1 . 8 A different organic compound ($C_{12}H_{26}$) can be broken down to produce C_6H_{14} and one other compound.

Complete the equation for the reaction.

[1 mark]

$$C_{12}H_{26} \rightarrow C_6H_{14} + C__ H__$$

4.3.1.2 Relative formula mass

Question 46 · continued

0 1 . 9 The percentage by mass of each element in C_6H_{14} is:

- 84% C
- 16% H

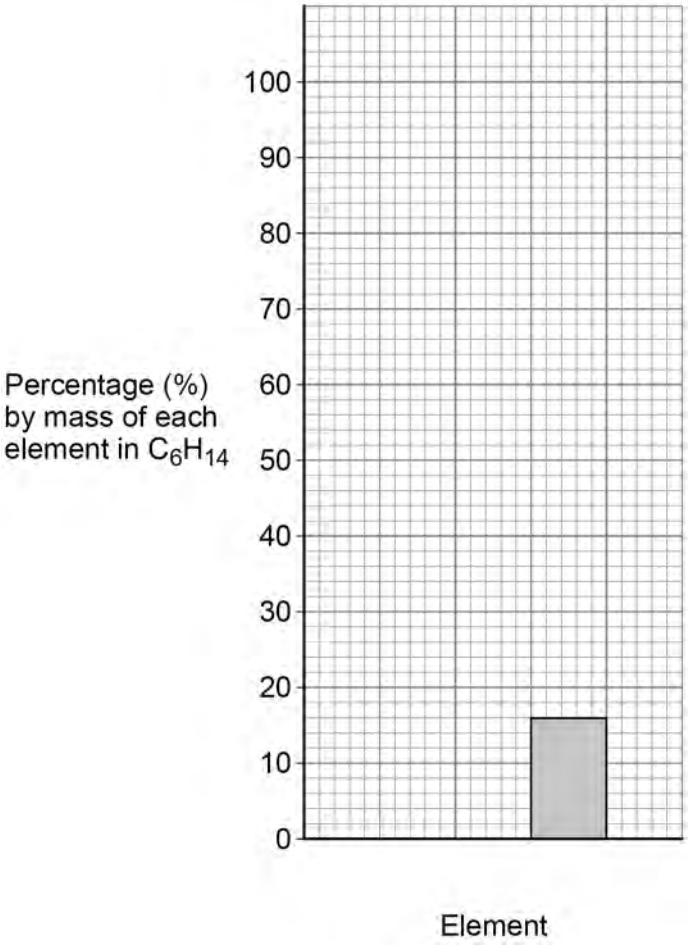
Complete **Figure 2**.

You should:

- label each element on the x-axis
- plot the percentage by mass of C in C_6H_{14}

[2 marks]

Figure 2



12

4.3.1.2 Relative formula mass

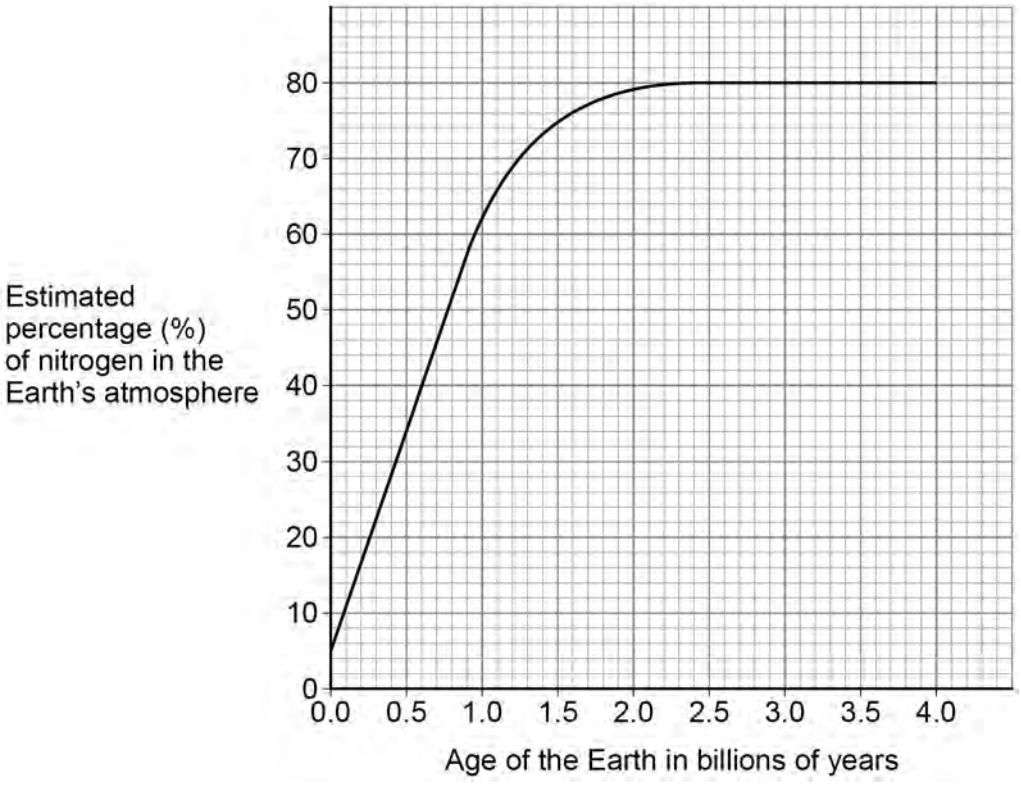
Question 47

June 2024 | 8462/2F | Original Q4

0 4 This question is about the Earth's atmosphere and naturally occurring polymers.

0 4 . 1 **Figure 5** shows how the estimated percentage of nitrogen in the Earth's atmosphere has changed since the Earth was formed.

Figure 5



Describe the trends shown by the graph.

Use data from **Figure 5**.

[3 marks]

Question 4 continues on the next page

Question 47 · continued

The percentage of oxygen in the Earth's atmosphere has increased since the Earth was formed.

This is because of photosynthesis.

The word equation for the photosynthesis reaction is:

carbon dioxide + water → glucose + oxygen

0 4 . 2 What happened to the percentage of carbon dioxide in the atmosphere when photosynthesis began?

[1 mark]

Tick (✓) **one** box.

- The percentage of carbon dioxide decreased. ☐
- The percentage of carbon dioxide stayed the same. ☐
- The percentage of carbon dioxide increased. ☐

0 4 . 3 The photosynthesis reaction takes in energy from the surroundings.

Complete the sentence.

Choose the answer from the box.

[1 mark]

carbon dioxide	**light**	**water**

The source of the energy used in photosynthesis is _____.

4.3.1.2 Relative formula mass

Question 47 · continued

0 4 . 4 Which **two** produce oxygen by photosynthesis?

[2 marks]

Tick (✓) **two** boxes.

- Algae ☐
- Animals ☐
- Plants ☐
- Viruses ☐
- Yeast ☐

0 4 . 5 The glucose produced during photosynthesis can form naturally occurring polymers.

Which **two** are naturally occurring polymers that can be produced from glucose?

[2 marks]

Tick (✓) **two** boxes.

- Cellulose ☐
- DNA ☐
- Poly(propene) ☐
- Protein ☐
- Starch ☐

Question 4 continues on the next page

4.3.1.2 Relative formula mass

Question 47 · continued

DNA molecules contain two polymer chains.

A DNA molecule has a relative formula mass (M_r) of approximately 140 000 000 000

0 4 . 6 What is the approximate relative formula mass (M_r) of the DNA molecule in standard form?

[1 mark]

Tick (✓) **one** box.

- 1.4×10^9 ☐
- 1.4×10^{10} ☐
- 1.4×10^{11} ☐
- 1.4×10^{12} ☐

0 4 . 7 What is the approximate relative formula mass (M_r) of each polymer chain in the DNA molecule?

[1 mark]

Tick (✓) **one** box.

- 70 000 000 000 ☐
- 140 000 000 000 ☐
- 280 000 000 000 ☐
- 560 000 000 000 ☐

0 4 . 8 Complete the sentence.

[1 mark]

The shape of a DNA molecule is a double _____ .

4.3.1.2 Relative formula mass

Question 47 · continued

0 4 . 9 How many different nucleotides are present in a molecule of DNA?

[1 mark]

Tick (✓) **one** box.

1 ☐

2 ☐

3 ☐

4 ☐

13

Turn over for the next question

4.3.1.2 Relative formula mass

Question 48

June 2024 | 8462/2F | Original Q8

0 8 A student investigated an aqueous solution of a salt.

The student identified that the salt solution contained only sodium ions and chloride ions.

0 8 . 1 Describe a test to identify sodium ions.

Give the result of the test.

[2 marks]

Test for sodium ions _____

_____

Result _____

_____

0 8 . 2 Describe a test to identify chloride ions.

Give the result of the test.

[2 marks]

Test for chloride ions _____

_____

Result _____

_____

4.3.1.2 Relative formula mass

Question 48 · continued

The student determined the concentration of sodium chloride in the salt solution.

This is the method used.

1. Weigh an empty evaporating dish.
2. Add 25.0 cm^3 of the salt solution into the evaporating dish.
3. Heat the evaporating dish and contents.
4. Weigh the evaporating dish and contents.
5. Repeat steps 3 to 4 until there is no further change in mass.
6. Repeat steps 1 to 5 three more times.

0 8 . 3 Why did the student heat the evaporating dish and contents until the mass did not change?

[1 mark]

0 8 . 4 How did the student calculate the mass of solid sodium chloride remaining after steps 1 to 5?

[1 mark]

Tick (✓) **one** box.

- Mass of 25 cm^3 of salt solution + mass of empty evaporating dish ☐
- Mass of 25 cm^3 of salt solution − mass of empty evaporating dish ☐
- Mass of evaporating dish and dry contents + mass of empty evaporating dish ☐
- Mass of evaporating dish and dry contents − mass of empty evaporating dish ☐

Question 8 continues on the next page

4.3.1.2 Relative formula mass

Question 48 · continued

0 8 . 5 The student calculated the concentration of sodium chloride in the salt solution.

Table 5 shows the results.

Table 5

Concentration of sodium chloride in g/dm^3			
Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
35.2	34.6	36.4	33.8

The percentage by mass of sodium ions in sodium chloride is 39.3%.

Calculate the mean concentration of sodium ions in the salt solution.

[4 marks]

Mean concentration = _____ g/dm^3

10

4.3.1.2 Relative formula mass

Question 49

June 2025 | 8462/1F | Original Q10

1 0 This question is about metals and metal oxides.

Tin (Sn) is extracted from tin oxide using carbon.

The equation for the reaction is:

$$SnO_2 + C \longrightarrow Sn + CO_2$$

1 0 . 1 Which substance is reduced in this reaction?

Give **one** reason for your answer.

Answer in terms of oxygen.

[2 marks]

Substance reduced _____

Reason _____

_____

1 0 . 2 Why can carbon be used to extract tin from tin oxide?

[1 mark]

_____

_____

Question 10 continues on the next page

4.3.1.2 Relative formula mass

Question 49 · continued

10.3 Cadmium (Cd) can be extracted by the reaction of cadmium oxide with carbon.

The equation for the reaction is:

$$CdO + C \longrightarrow Cd + CO$$

Calculate the percentage atom economy for the production of cadmium in this reaction.

Relative atomic masses (A_r): C = 12 Cd = 112

Relative formula mass (M_r): CdO = 128

[3 marks]

Percentage atom economy = _____ %

10.4 Tungsten is a transition metal.

Potassium is a Group 1 metal.

Give **two** differences between the properties of tungsten and the properties of potassium.

[2 marks]

1 _____

2 _____

4.3.1.2 Relative formula mass

Question 49 · continued June 2025 | 8462/1F | Original Q10

Tungsten oxide reacts with hydrogen to give tungsten (W) and water.

10.5 The equation for the reaction is:

$$WO_3 + 3\,H_2 \longrightarrow W + 3\,H_2O$$

The law of conservation of mass states:

'The mass of the products equals the mass of the reactants during a chemical reaction.'

Show that the equation obeys the law of conservation of mass.

Relative atomic mass (A_r): W = 184

Relative formula masses (M_r): H_2 = 2 WO_3 = 232 H_2O = 18

[2 marks]

10.6 The reaction producing tungsten has a high atom economy.

Why is it important to use reactions with a high atom economy in industry?

[1 mark]

11

4.3.1.2 Relative formula mass

Question 50

June 2025 | 8462/2F | Original Q2

0 2 Alkanes and alkenes are hydrocarbons.

Hydrocarbon molecules are made up of hydrogen and carbon atoms only.

An alkene has the formula C_3H_6

0 2 . 1 Which alkene has the formula C_3H_6?

[1 mark]

Tick (✓) **one** box.

Butene ☐

Ethene ☐

Propene ☐

0 2 . 2 How many atoms are there in a molecule of C_3H_6?

[1 mark]

Tick (✓) **one** box.

2 ☐ 3 ☐ 6 ☐ 9 ☐

0 2 . 3 Which is a use of C_3H_6?

[1 mark]

Tick (✓) **one** box.

Making a polymer ☐

Making ammonia ☐

Making glass ☐

4.3.1.2 Relative formula mass

Question 50 · continued

0 2 . 4 The percentage (%) by mass of each element in a molecule of C_3H_6 is:

- hydrogen 14%
- carbon 86%.

Figure 1 shows the percentage by mass of hydrogen in a molecule of C_3H_6

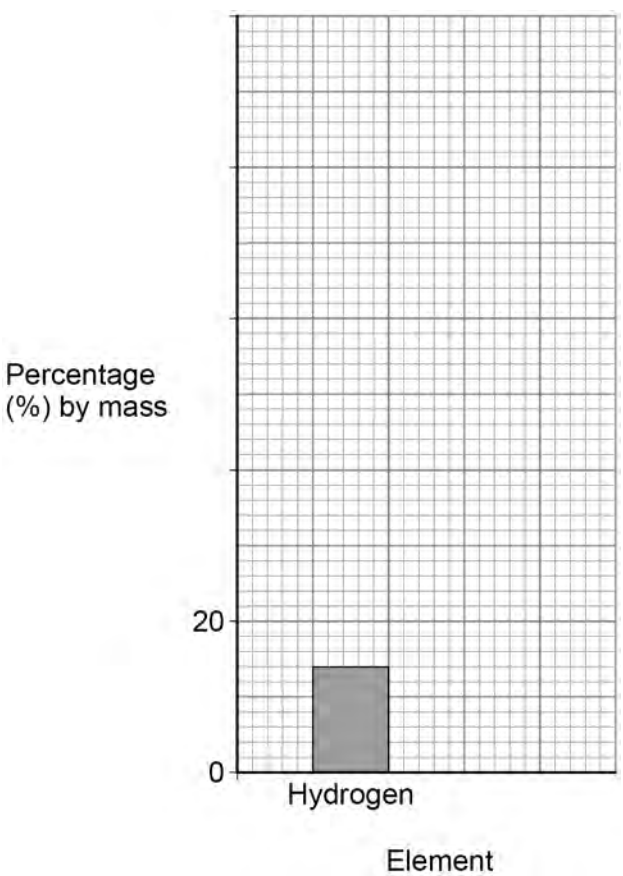
Complete **Figure 1**.

You should:

- complete the *y*-axis scale
- plot the percentage by mass of carbon as a bar
- label the bar plotted for carbon.

[3 marks]

Figure 1



4.3.1.2 Relative formula mass

Question 50 · continued

Alkanes can be cracked to produce alkenes and smaller alkane molecules.

0 2 . 5 Describe a test for alkenes.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 2 . 6 $C_{10}H_{22}$ can be cracked to produce C_3H_6 and an alkane.

Complete the equation for the reaction.

[1 mark]

$$C_{10}H_{22} \longrightarrow C_3H_6 + C___H_{16}$$

0 2 . 7 Complete the sentence.

Choose the answer from the box.

[1 mark]

ceramics	**fertilisers**	**fuels**

Smaller alkanes from cracking are useful as _____.

4.3.1.2 Relative formula mass

Question 50 · continued

High temperatures between 450 °C and 750 °C are used in cracking reactions.

0 2 . 8 Which statement describes the molecules at 750 °C compared with the molecules at 450 °C?

[1 mark]

Tick (✓) **one** box.

- The molecules collide more frequently at 750 °C. ☐
- The molecules have less energy at 750 °C. ☐
- The molecules move more slowly at 750 °C. ☐

0 2 . 9 How does the rate of reaction at 750 °C compare with the rate of reaction at 450 °C?

[1 mark]

_____

_____

12

4.3.1.2 Relative formula mass

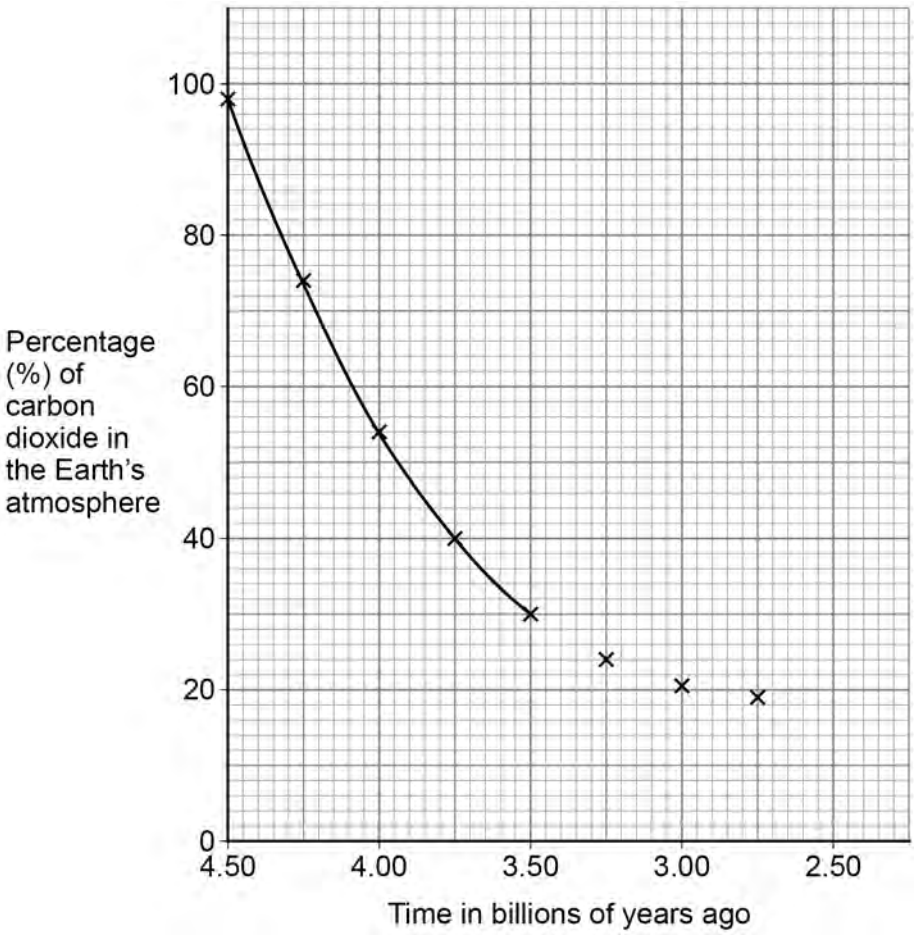
Question 51

June 2025 | 8462/2F | Original Q6

0 6 The Earth's atmosphere has changed over time.

Figure 5 shows the percentage of carbon dioxide in the Earth's atmosphere between 4.5 billion and 2.75 billion years ago.

Figure 5



0 6 . 1 Complete **Figure 5**.

You should extend the line of best fit to the plotted point at 2.75 billions of years ago.

[1 mark]

4.3.1.2 Relative formula mass

Question 51 · continued

0 6 . 2 What was the percentage (%) of carbon dioxide in the Earth's atmosphere 3.75 billions of years ago?

Use **Figure 5**.

[1 mark]

_____ %

0 6 . 3 The percentage of carbon dioxide changed between 4.5 and 3.0 billion years ago.

Which was a cause of this change?

Use **Figure 5**.

[1 mark]

Tick (✓) **one** box.

Carbon dioxide was dissolved in oceans. ☐

Carbon dioxide was produced during combustion of fossil fuels. ☐

Carbon dioxide was released during volcanic activity. ☐

Question 6 continues on the next page

4.3.1.2 Relative formula mass

Question 51 · continued

Table 2 shows information about the percentage of nitrogen present in the Earth's atmosphere.

Table 2

Time in billions of years ago	Percentage (%) of nitrogen
4.5	4
4.0	34
3.5	62
3.0	75
2.5	78

0 6 . 4 The percentage of nitrogen changed between 4.5 and 2.5 billion years ago.

Which was a cause of this change?

Use **Table 2**.

[1 mark]

Tick (✓) **one** box.

Nitrogen was dissolved in oceans. ☐

Nitrogen was produced during combustion of fossil fuels. ☐

Nitrogen was released during volcanic activity. ☐

4.3.1.2 Relative formula mass

Question 51 · continued

0 6 . 5 When did the percentage of nitrogen in the Earth's atmosphere become similar to the percentage of nitrogen in the Earth's atmosphere today?

Use **Table 2**.

[1 mark]

Tick (✓) **one** box.

2.5 billion years ago ☐

3.0 billion years ago ☐

3.5 billion years ago ☐

4.0 billion years ago ☐

4.5 billion years ago ☐

0 6 . 6 Which **two** gases may also have been present in the Earth's early atmosphere?

[2 marks]

Tick (✓) **two** boxes.

Ammonia ☐

Chlorine ☐

Helium ☐

Hydrogen ☐

Methane ☐

0 6 . 7 Name the process that started to produce oxygen in the Earth's atmosphere 2.7 billion years ago.

[1 mark]

_____

8