AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.3.1.2

Relative formula mass

Past-paper questions

Tier	**Higher**
Question groups	**49**
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

January 2007 | CHY1H | Original Q5 | Legacy

5 Crude oil is a mixture of mostly alkanes.

(a) Crude oil is separated into useful fractions by fractional distillation.

(i) Describe and explain how the mixture of alkanes is separated by fractional distillation.

.....

.....

.....

.....

.....

.....

.....

(3 marks)

(ii) The table gives the name and formula for each of the first three alkanes.

Complete the table to show the formula of butane.

Name of alkane	Formula
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	

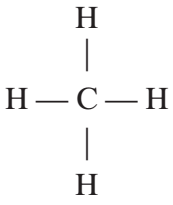
(1 mark)

4.3.1.2 Relative formula mass

Question 01 · continued

BLANK

(b) The structural formula of methane, CH_4, is:



Draw the structural formula of propane, C_3H_8

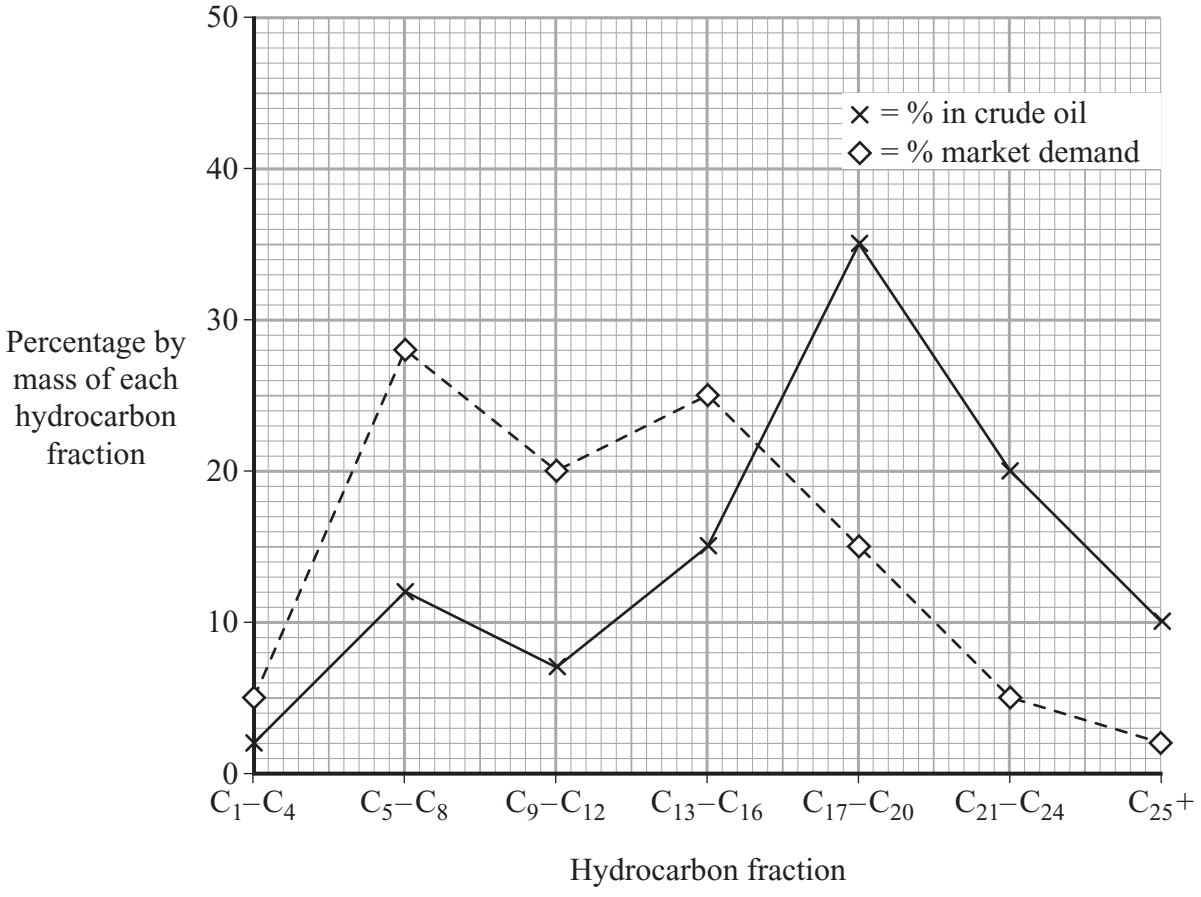
(1 mark)

Question 5 continues on the next page

Question 01 · continued

BLANK

(c) The relative amounts of and the market demand for some hydrocarbons from the fractional distillation of crude oil are shown in the graph.



(i) Why is the market demand for the $C_5–C_8$ fraction higher than the market demand for the $C_{21}–C_{24}$ fraction?

.....

.....

(1 mark)

(ii) Cracking is used to break down large hydrocarbon molecules into smaller hydrocarbon molecules.

Complete the symbol equation by writing in the formula of the other hydrocarbon.

$C_{20}H_{42} \rightarrow C_{16}H_{34} + 2$ .....

(1 mark)

4.3.1.2 Relative formula mass

Question 01 · continued

BLANK

(iii) The C_5-C_8 fraction has low supply and high market demand.

Suggest **three** ways in which the oil industry could overcome this problem.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

10

4.3.1.2 Relative formula mass

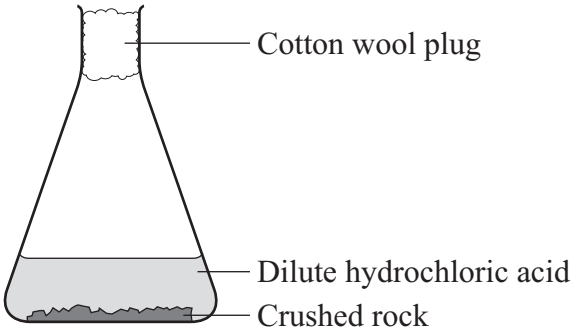
Question 02

June 2007 | CHY1A | Original Q4 | Legacy

QUESTION FOUR

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.

4A 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

Question 02 · continued

4B 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 %

4C 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.

4D 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.

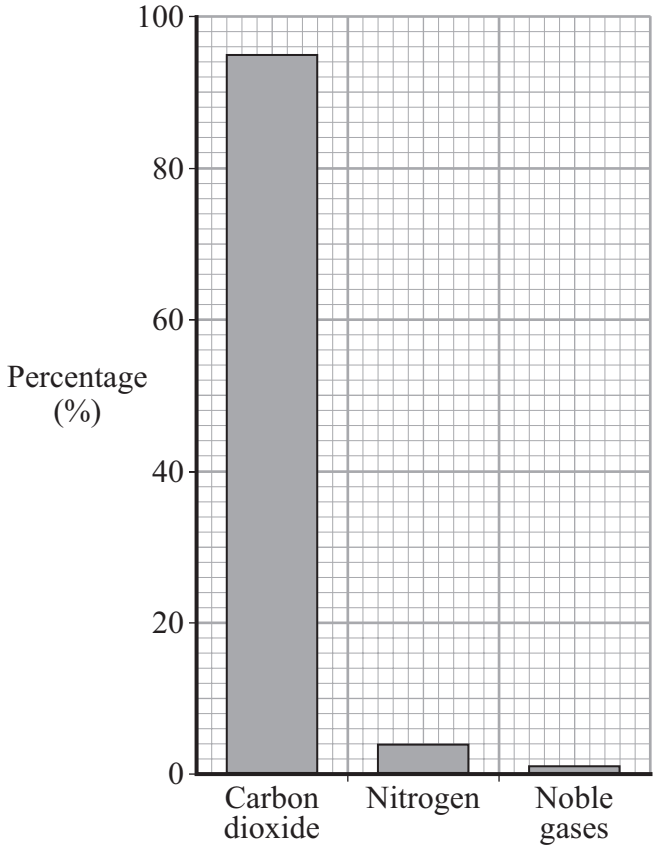
4.3.1.2 Relative formula mass

Question 03

June 2007 | CHY1B | Original Q5 | Legacy

QUESTION FIVE

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



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

Scientists think that most of the carbon dioxide . . .

1 came out of solution from the oceans.

2 was released from volcanoes.

3 was given off as carbonate rocks decomposed.

4 was released as fossil fuels formed.

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

1 contains less nitrogen.

2 contains more carbon dioxide.

3 does not contain noble gases.

4 contains more water vapour.

4.3.1.2 Relative formula mass

Question 03 · continued

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

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

1 They increased the percentage of carbon dioxide.

2 They decreased the percentage of nitrogen.

3 They increased the percentage of oxygen.

4 They increased the percentage of ammonia.

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

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

1 carbon dioxide.

2 nitrogen.

3 oxygen.

4 ammonia.

4.3.1.2 Relative formula mass

Question 04

January 2008 | CHY2H | Original Q3 | Legacy

3 (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 05

June 2008 | CHY2H | Original Q1 | Legacy

1 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.

1 (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)

1 (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 05 · continued

for mark

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

Calculate the mass of fluorine in this tube of toothpaste.

.....

.....

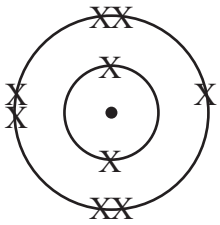
.....

.....

Mass of fluorine = ... g

(1 mark)

1 (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 06

June 2008 | CHY2H | Original Q8 | Legacy

8 Epoxyethane has the formula C_2H_4O. It is used to make antifreeze and some types of plastic.

When choosing a method of making a chemical, it is important to consider:

- the percentage yield
- the atom economy.

Epoxyethane can be made from ethene by two different methods. The overall equation for each method is shown below.

Method 1

$$\underset{\text{ethene}}{C_2H_4} + Cl_2 + Ca(OH)_2 \rightarrow \underset{\text{epoxyethane}}{C_2H_4O} + CaCl_2 + H_2O$$

Method 2

$$\underset{\text{ethene}}{2C_2H_4(g)} + O_2(g) \overset{\text{catalyst}}{\rightleftharpoons} \underset{\text{epoxyethane}}{2C_2H_4O(g)}$$

8 (a) The table gives the relative formula masses (M_r) of the reactants and products for **Method 1**.

Formula of reactant or product	Relative formula mass (*M*r)
H_2O	18
C_2H_4	28
C_2H_4O	44
Cl_2	71
$Ca(OH)_2$	74
$CaCl_2$	111

The percentage atom economy can be calculated using:

$$\text{Percentage atom economy} = \frac{M_r \text{ of useful product}}{\text{Total } M_r \text{ of all reactants added together}} \times 100\%$$

The percentage atom economy for **Method 2** is 100%.

4.3.1.2 Relative formula mass

Question 06 · continued

for mark

8 (a) Calculate the percentage atom economy for **Method 1**.

.....

.....

.....

.....

(2 marks)

8 (b) **Method 2** has the higher atom economy.

Suggest why this is an advantage.

.....

.....

.....

.....

(2 marks)

8 (c) State and explain how an increase in pressure would affect the equilibrium yield of epoxyethane using **Method 2**.

.....

.....

.....

.....

(2 marks)

8 (d) One problem with **Method 2** is that ethene can also react with oxygen to make carbon dioxide and water.

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

How might this reaction affect the percentage yield of epoxyethane?

.....

.....

(1 mark)

7

4.3.1.2 Relative formula mass

Question 07

June 2009 | CHY2H | Original Q2 | Legacy

2 This question is about methods of treating water.

2 (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.

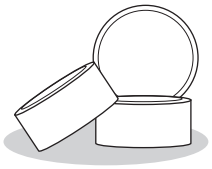
$$Cl_2(g) + H_2O(l) \rightleftharpoons 2H^+(aq) + OCl^-(aq) + Cl^-(aq)$$

An acidic solution is produced when chlorine reacts with water.

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

(1 mark)

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



The formula of calcium hypochlorite is $CaCl_2O_2$

2 (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)

2 (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 07 · continued

for mark

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

.....

.....

Mass of chlorine = ... g

(1 mark)

2 (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.

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

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

.....

.....

(1 mark)

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

What is a *precipitate*?

.....

.....

(1 mark)

2 (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 08

November 2009 | CHY1BP | Original Q9 | Legacy

QUESTION NINE

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

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

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

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

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

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

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

1 there is too much evidence available.

2 the information can be interpreted in different ways.

3 the data is inaccurate.

4 geological records do not go back far enough.

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

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

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

3 The atmosphere now contains more than 20% oxygen.

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

4.3.1.2 Relative formula mass

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

1 Some carbon dioxide has dissolved in the oceans.

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

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

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

9D Which one of the following statements is true?

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

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

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

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

END OF TEST

4.3.1.2 Relative formula mass

Question 09

3 (a) The table gives information about two isotopes of hydrogen, hydrogen-1 and hydrogen-2.

	Hydrogen-1	Hydrogen-2
Atomic number	1	1
Mass number	1	2

An atom of hydrogen-1 is represented as: $^{1}_{1}\mathbf{H}$

Show how an atom of hydrogen-2 is represented.

(1 mark)

3 (b) (i) Calculate the relative formula mass (M_r) of water, H_2O

Relative atomic masses: H = 1; O = 16.

.....

.....

Relative formula mass (M_r) = ...

(1 mark)

3 (b) (ii) Simple molecules like water have low boiling points.

Explain why, in terms of molecules.

.....

.....

.....

.....

(2 marks)

4.3.1.2 Relative formula mass

Question 09 · continued

for mark

3 (c) Molecules of heavy water contain two atoms of hydrogen-2 instead of two atoms of hydrogen-1.

Explain why a molecule of heavy water has more mass than a normal water molecule. You should refer to the particles in the nucleus of the two different hydrogen atoms in your answer.

.....

.....

.....

.....

.....

(2 marks)

6

Turn over for the next question

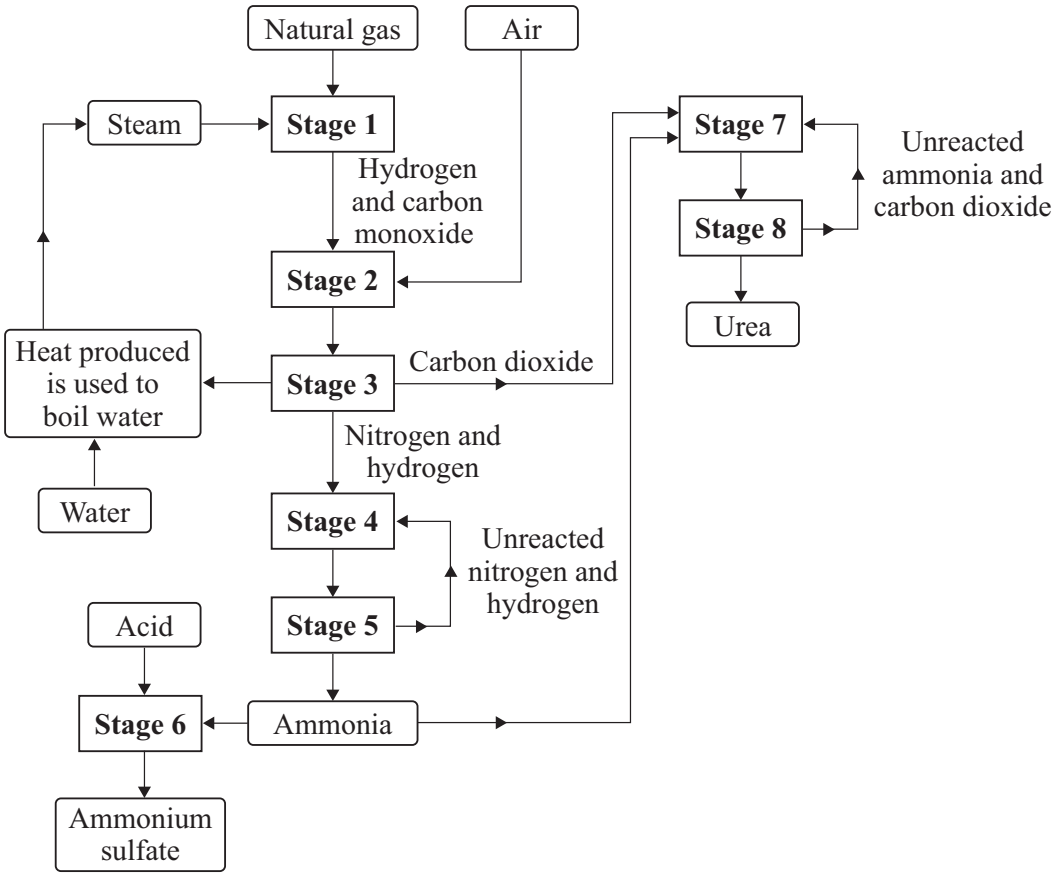
4.3.1.2 Relative formula mass

Question 10

January 2010 | CHY2H | Original Q6 | Legacy

6 Ammonium sulfate and urea are made from ammonia.
These compounds are used by farmers.

The flow diagram shows the stages to make ammonium sulfate and urea.



6 (a) Give **two** examples from the flow diagram of efficient use of energy or materials.

.....

.....

.....

.....

(2 marks)

4.3.1.2 Relative formula mass

Question 10 · continued

for mark

6 (b) Why do farmers use ammonium compounds?

.....

.....

(1 mark)

6 (c) The equation for a reaction that takes place in **Stage 1** is given below.

Balance this equation by putting the correct number on the dotted line.

$$CH_4 + H_2O \rightarrow CO + \ldots\ldots H_2$$

(1 mark)

6 (d) The equation for the reaction in **Stage 4** is shown below.

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

The forward reaction is exothermic.

6 (d) (i) Explain why, at equilibrium, the yield of ammonia for this reaction is greater at **low** temperatures.

.....

.....

(1 mark)

6 (d) (ii) Explain why a high temperature, 450 °C, is used in **Stage 4**.

.....

.....

(1 mark)

6 (e) Name the acid used in **Stage 6** to make ammonium sulfate.

..... acid

(1 mark)

Question 6 continues on the next page

4.3.1.2 Relative formula mass

Question 10 · continued

for mark

6 (f) **Stage 7** can be represented by this equation.

$$\underset{\text{ammonia}}{2NH_3} + CO_2 \rightarrow \underset{\text{urea}}{NH_2CONH_2} + H_2O$$

The table gives the relative formula masses (M_r) of the reactants and the products for this reaction.

Formula of reactant or product	Relative formula masses (M_r)
NH_3	17
CO_2	44
NH_2CONH_2	60
H_2O	18

Use information from the table to help you answer (f)(i) and (f)(ii).

6 (f) (i) One factory produces 6000 g of urea each second. Calculate the mass of ammonia needed to make 6000 g of urea.

.....

.....

.....

.....

Mass of ammonia needed = ... g

(3 marks)

6 (f) (ii) Percentage atom economy can be calculated using:

$$\text{Percentage atom economy} = \frac{M_r \text{ of useful product}}{\text{total } M_r \text{ of all reactants added together}} \times 100\%$$

Calculate the percentage atom economy for the reaction in **Stage 7**

.....

.....

.....

Percentage atom economy = ... %

(2 marks)

12

4.3.1.2 Relative formula mass

Question 11

March 2010 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

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

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

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

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

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

1 it would react with the other gases present.

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

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

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

4.3.1.2 Relative formula mass

Question 11 · continued March 2019 | CHY1BP | Original Q8 | Legacy

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

1 None

2 1

3 2

4 3

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

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

2 it is the most abundant of the noble gases.

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

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

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

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

1 has dissolved in the oceans.

2 has been reduced to carbon monoxide.

3 has decomposed to form carbon and oxygen.

4 has been released by plants.

4.3.1.2 Relative formula mass

Question 12

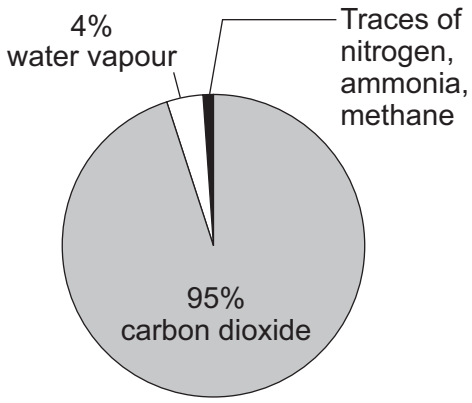
June 2010 | CHY1H | Original Q2 | Legacy

2 (a) Scientists have suggested that:

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

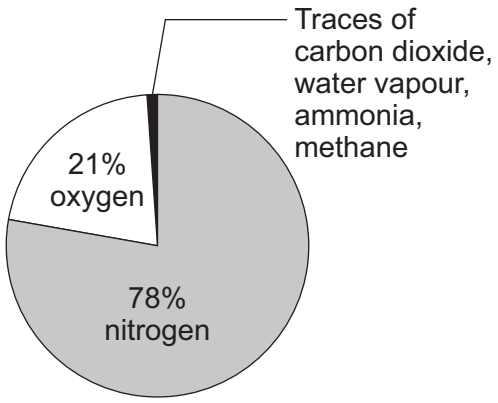
The pie charts show the approximate percentages of gases in the Earth's early atmosphere and in the Earth's atmosphere today.

Earth's early atmosphere



Average surface temperature above 400 °C

Earth's atmosphere today



Average surface temperature 20 °C

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

.....

.....

.....

.....

(2 marks)

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

1 .....

.....

2 .....

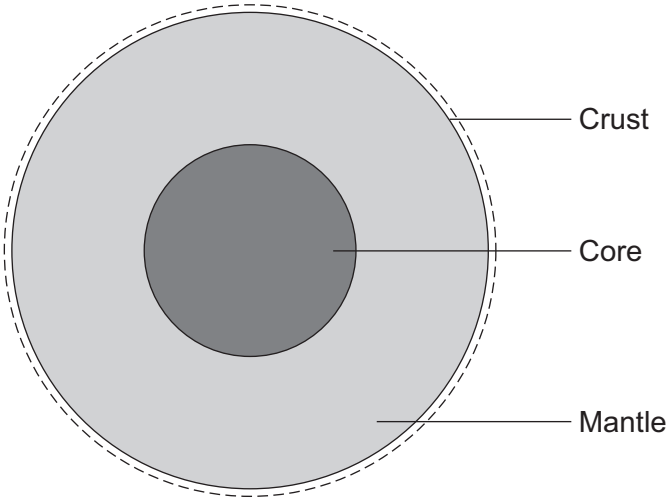
.....

(2 marks)

4.3.1.2 Relative formula mass

Question 12 · continued

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



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

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

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

.....

.....

(1 mark)

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

.....

.....

.....

.....

.....

.....

(3 marks)

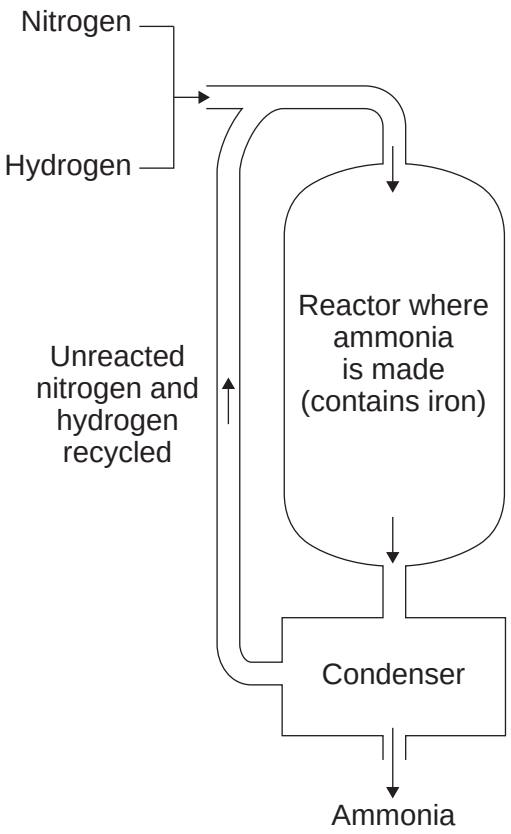
8

4.3.1.2 Relative formula mass

Question 13

June 2010 | CHY2H | Original Q1 | Legacy

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



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

nitrogen + ... → .....

(1 mark)

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

.....

.....

(1 mark)

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

.....

.....

.....

.....

(2 marks)

4.3.1.2 Relative formula mass

Question 13 · continued

1 (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)

1 (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 ☐

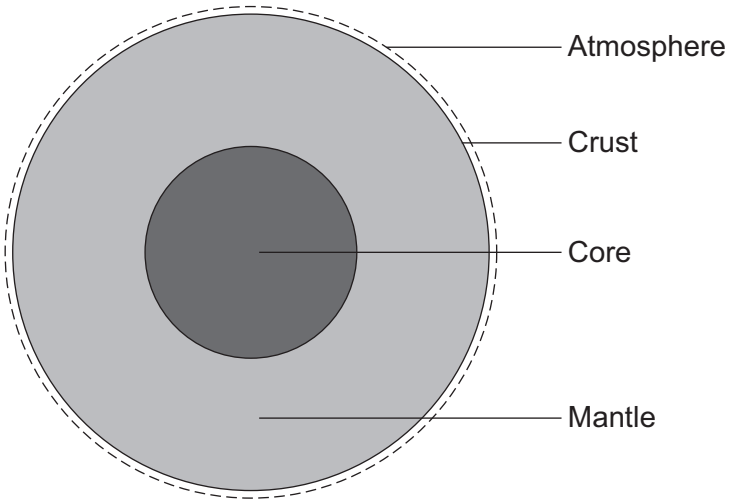
(2 marks)

8

4.3.1.2 Relative formula mass

Question 14

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



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

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

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

.....

.....

.....

.....

(2 marks)

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

Explain how carbon dioxide is released from limestone.

.....

.....

.....

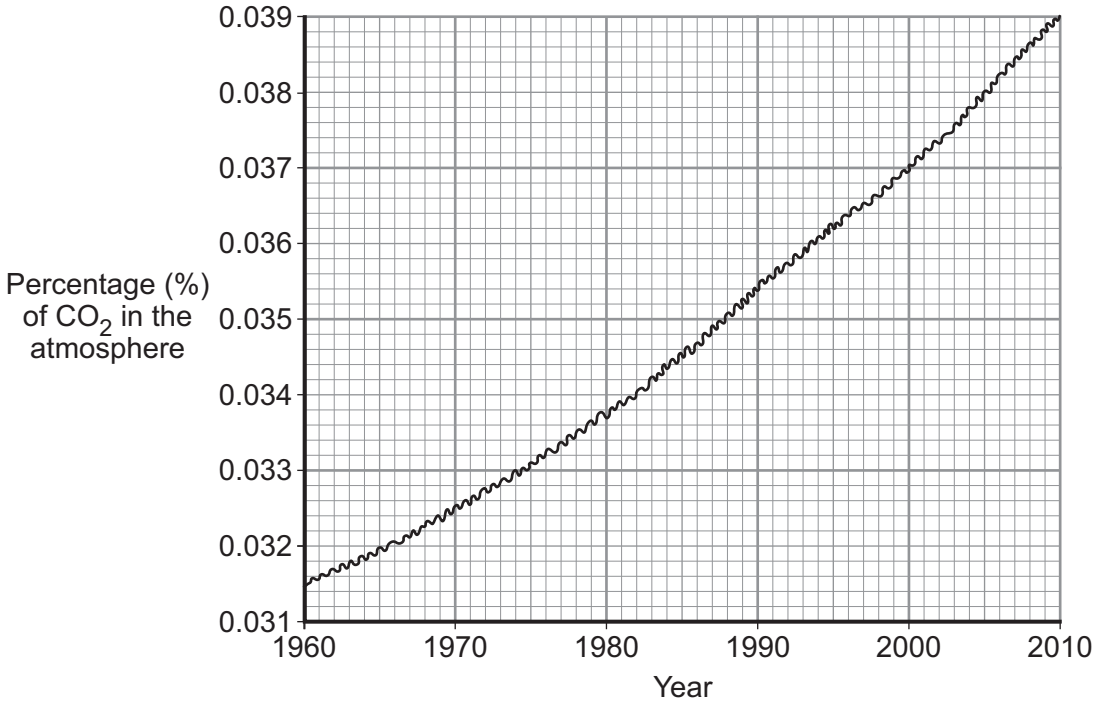
.....

(2 marks)

4.3.1.2 Relative formula mass

Question 14 · continued

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



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

.....

.....

.....

.....

.....

.....

.....

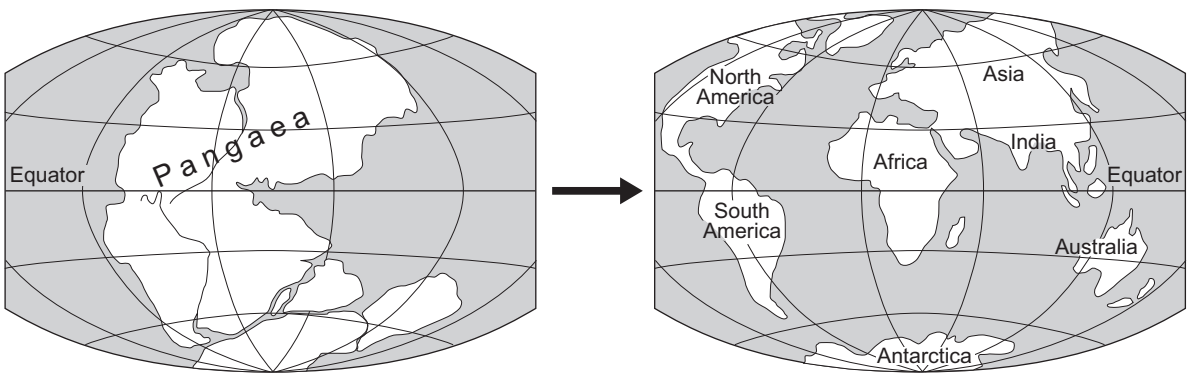
(3 marks)

Question 3 continues on the next page

4.3.1.2 Relative formula mass

Question 14 · continued

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



200 million years ago **Today**

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

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

.....

.....

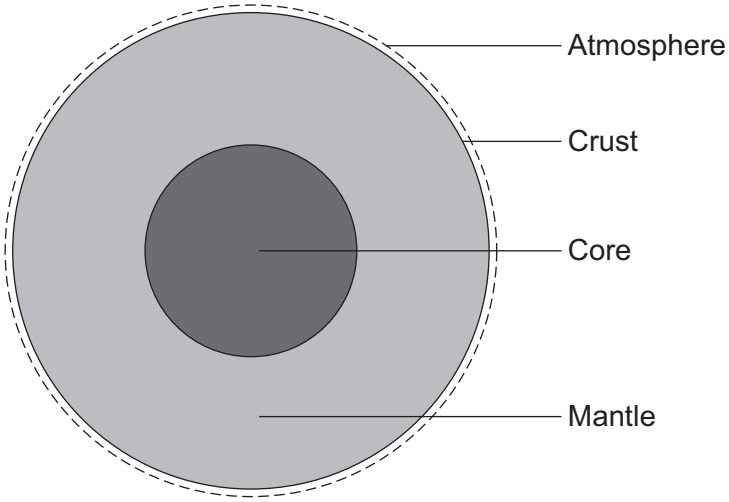
(1 mark)

4.3.1.2 Relative formula mass

Question 14 · continued

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

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



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

.....

.....

.....

.....

.....

.....

(3 marks)

11

4.3.1.2 Relative formula mass

Question 15

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



2 (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.

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

.....

.....

.....

Relative atomic mass (A_r) = ...
(2 marks)

2 (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 15 · continued

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

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

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

.....

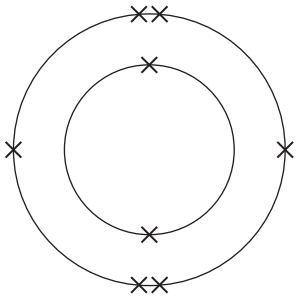
.....

.....

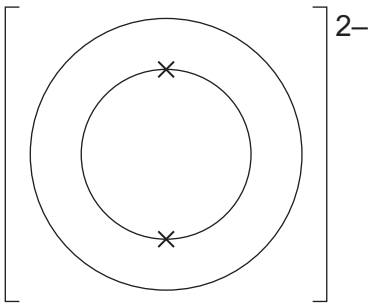
.....

(2 marks)

2 (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 16

6 The picture shows a wooden bowl.
The pieces of wood used for this bowl were dyed different colours.



The artist who made the bowl explained why he dissolved the coloured dyes in methanol.

> I use different coloured dyes dissolved in methanol.
> I use methanol because with dyes dissolved in water the wood needs to be soaked for a longer time.
> The bowl dries more quickly if I use methanol instead of water.

6 (a) (i) Why is using methanol an advantage to the artist?

.....

.....

(1 mark)

6 (a) (ii) The bonds within a methanol molecule are strong, covalent bonds.

Explain why methanol has a low boiling point.

.....

.....

.....

.....

.....

(2 marks)

4.3.1.2 Relative formula mass

Question 16 · continued

6 (b) Methanol is made by reacting carbon monoxide with hydrogen.

The equation for this reaction is:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

The best equilibrium yield of methanol is obtained when the temperature is low and when the pressure is high.

Explain why the best equilibrium yield is obtained:

6 (b) (i) when the temperature is low

.....

.....

(1 mark)

6 (b) (ii) when the pressure is high.

.....

.....

(1 mark)

6 (b) (iii) In industry a high temperature is used for this reaction. This gives a fast rate of reaction. The increase in temperature gives the particles more energy.

Explain, in terms of particles, why this makes the reaction go faster.

.....

.....

.....

.....

.....

.....

(2 marks)

Question 6 continues on the next page

4.3.1.2 Relative formula mass

Question 16 · continued

6 (c) (i) Calculate the maximum mass of methanol that could be made from 14 g of carbon monoxide.

$$CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$$

Relative formula masses (M_r): CO = 28; CH_3OH = 32.

.....

.....

.....

.....

.....

Maximum mass of methanol = ... g
(2 marks)

6 (c) (ii) In an experiment the actual mass of methanol made from 14 g of carbon monoxide was 12 g. Use this information and your answer from part (c)(i) to calculate the percentage yield of methanol in this experiment.

(If you did not get an answer to part (c)(i) then assume that the maximum yield is 18 g. This is **not** the correct answer to part (c)(i).)

.....

.....

Percentage yield of methanol = ...%
(2 marks)

6 (c) (iii) Suggest **one** reason why the yield obtained is less than the maximum yield.

.....

.....
(1 mark)

12

4.3.1.2 Relative formula mass

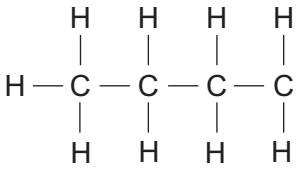
Question 17

June 2011 | CHY1H | Original Q5 | Legacy

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

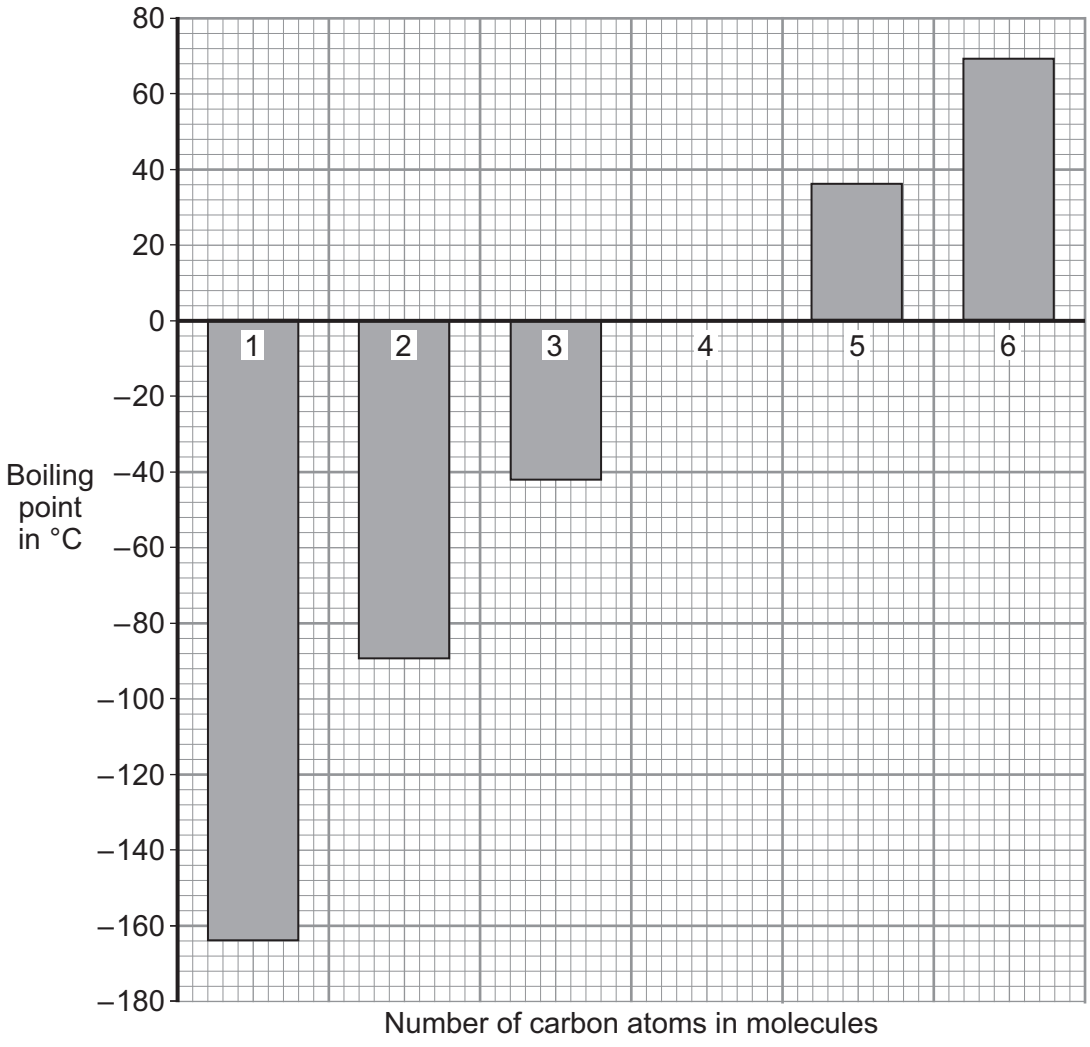
5 (a) The general formula of an alkane is C_nH_{2n+2}

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



(1 mark)

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



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

.....

.....

(1 mark)

4.3.1.2 Relative formula mass

Question 17 · continued

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

1 .....

.....

2 .....

.....

(2 marks)

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

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

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

(1 mark)

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

.....

.....

(1 mark)

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

.....

.....

.....

.....

.....

.....

(2 marks)

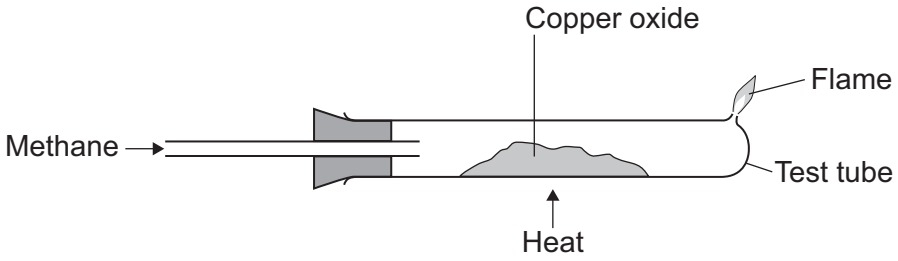
8

4.3.1.2 Relative formula mass

Question 18

June 2011 | CHY2H | Original Q2 | Legacy

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



2 (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)

2 (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)

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

.....

.....

.....

Percentage of copper = ... %

(2 marks)

4.3.1.2 Relative formula mass

Question 18 · continued June 2011 | CHY2H | Original Q2 | Legacy

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

.....

.....

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

2 (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

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

.....

.....

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

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

.....

.....
(1 mark)

2 (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)

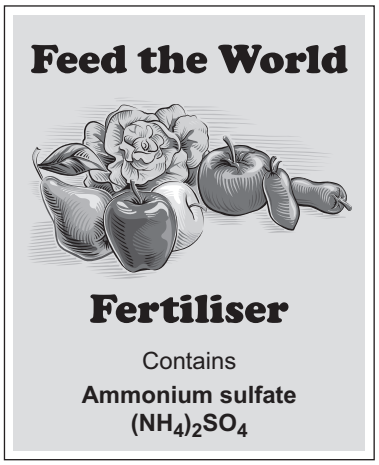
10

4.3.1.2 Relative formula mass

Question 19

June 2011 | CHY3H | Original Q5 | Legacy

5 Ammonium sulfate is an artificial fertiliser.



5 (a) (i) When this fertiliser is warmed with sodium hydroxide solution, ammonia gas is given off. Describe and give the result of a test for ammonia gas.

Test .....

.....

Result .....

.....

(2 marks)

5 (a) (ii) Describe and give the result of a chemical test to show that this fertiliser contains sulfate ions (SO_4^{2-}).

Test .....

.....

Result .....

.....

(2 marks)

5 (b) Ammonium sulfate is made by reacting sulfuric acid (a *strong* acid) with ammonia solution (a *weak* alkali).

5 (b) (i) Explain the meaning of *strong* in terms of ionisation.

.....

(1 mark)

4.3.1.2 Relative formula mass

Question 19 · continued June 2011 | CHY3H | Original Q5 | Legacy

5 (b) (ii) A student made some ammonium sulfate in a school laboratory.

The student carried out a titration, using a suitable indicator, to find the volumes of sulfuric acid and ammonia solution that should be reacted together.

Name a suitable indicator for strong acid-weak alkali titrations.

.....

(1 mark)

5 (b) (iii) The student found that 25.0 cm^3 of ammonia solution reacted completely with 32.0 cm^3 of sulfuric acid of concentration 0.050 moles per cubic decimetre.

The equation that represents this reaction is:

$$H_2SO_4\,(aq) + 2NH_3\,(aq) \rightarrow (NH_4)_2SO_4\,(aq)$$

Calculate the concentration of this ammonia solution in moles per cubic decimetre.

.....

.....

.....

.....

.....

Concentration = ... moles per cubic decimetre

(3 marks)

5 (b) (iv) Use your answer to (b)(iii) to calculate the concentration of ammonia in grams per cubic decimetre.

(If you did not answer part (b)(iii), assume that the concentration of the ammonia solution is 0.15 moles per cubic decimetre. This is **not** the correct answer to part (b)(iii).)

Relative formula mass of ammonia (NH_3) = 17.

.....

.....

.....

Concentration = ... grams per cubic decimetre

(2 marks)

11

4.3.1.2 Relative formula mass

Question 20

June 2011 | CHY3H | Original Q6 | Legacy

6 *Unsaturated* organic compounds are used to make polymers.

6 (a) (i) Describe what you would **see** when bromine water reacts with an *unsaturated* organic compound.

.....

.....

(1 mark)

6 (a) (ii) In terms of structure, what makes an organic compound *unsaturated*?

.....

.....

(1 mark)

6 (b) When 2.1 g of an unsaturated hydrocarbon were completely burned in oxygen, 6.6 g of carbon dioxide and 2.7 g of water were the only products.

Relative formula masses: CO_2 = 44; H_2O = 18.

Use this information to calculate the number of moles of carbon dioxide and of water produced in this reaction. Use your answer to calculate the empirical formula of the hydrocarbon.

You must show your working to gain full marks.

.....

.....

.....

.....

.....

.....

.....

Empirical formula = ...

(3 marks)

5

4.3.1.2 Relative formula mass

Question 21

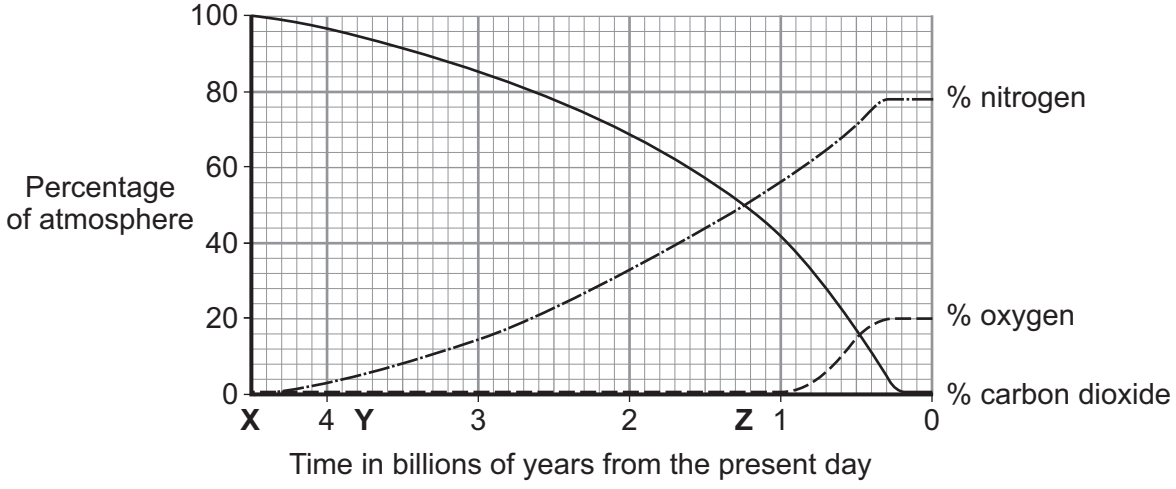
November 2011 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

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

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

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



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

1 1.3 billion years

2 1.6 billion years

3 2.4 billion years

4 2.9 billion years

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

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

1 nitrogen

2 carbon dioxide

3 oxygen

4 water vapour

4.3.1.2 Relative formula mass

Question 21 · continued

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

Which of the following statements could explain this reduction?

Most of the carbon dioxide . . .

1 dissolved in the oceans.

2 was absorbed by plants.

3 was absorbed to form carbonate rocks in the mantle.

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

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

1 categoric variables plotted against a discrete variable.

2 discrete variables plotted against a continuous variable.

3 continuous variables plotted against a continuous variable.

4 continuous variables plotted against a discrete variable.

4.3.1.2 Relative formula mass

Question 22

January 2012 | CH1HP | Original Q4 | Legacy

4 Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.



4 (a) Iron is extracted by heating a mixture of iron oxide and carbon in a blast furnace.

4 (a) (i) Name this type of reaction.

.....

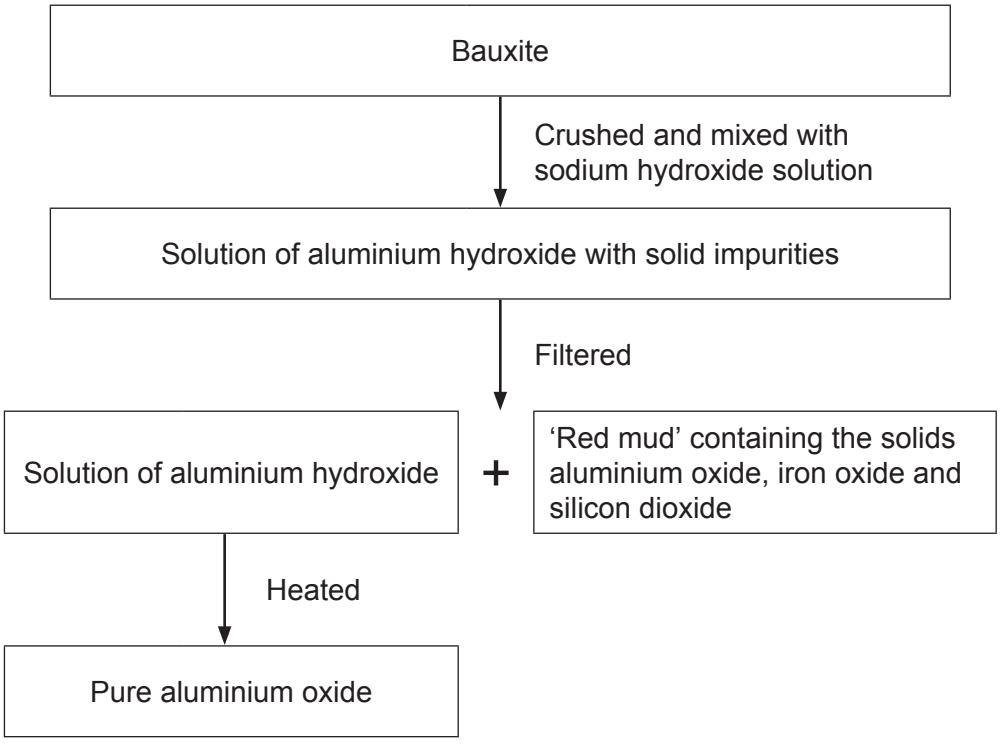
(1 mark)

4 (a) (ii) Balance the symbol equation for this reaction.

$2Fe_2O_3$ + ... C → ..... Fe + ... CO_2

(1 mark)

4 (b) Aluminium ore, bauxite, contains aluminium oxide, iron oxide and silicon dioxide.
Aluminium is extracted by electrolysis of aluminium oxide.



4.3.1.2 Relative formula mass

Question 22 · continued January 2012 | CH1HP | Original Q4 | Legacy

The 'red mud' which is dumped in very large ponds contains:

Name of solid	Percentage (%)
Aluminium oxide	10
Iron oxide	65
Silicon dioxide	25

4 (b) (i) 100 tonnes of bauxite produced 50 tonnes of pure aluminium oxide and 50 tonnes of 'red mud'.

What percentage of aluminium oxide did the bauxite contain?

.....

Answer = ... %

(1 mark)

4 (b) (ii) Apart from the solids shown in the table, name **one** other substance that would be in the 'red mud'.

.....

(1 mark)

4 (b) (iii) The purification of the aluminium oxide is usually done near to the bauxite quarries.

Suggest **one** reason why.

.....

(1 mark)

4 (c) Aluminium is used to make many things including cans.

During one year in the USA:
- 100 billion aluminium cans were sold
- 55 billion aluminium cans were recycled.

Give **one** environmental impact of recycling aluminium cans and **one** ethical or social impact of recycling aluminium cans.

Environmental .....

.....

Ethical or social .....

.....

(2 marks)

7

4.3.1.2 Relative formula mass

Question 23

June 2012 | CH1HP | Original Q4 | Legacy

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

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

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

.....

.....

.....

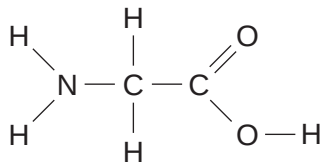
.....

(2 marks)

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

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

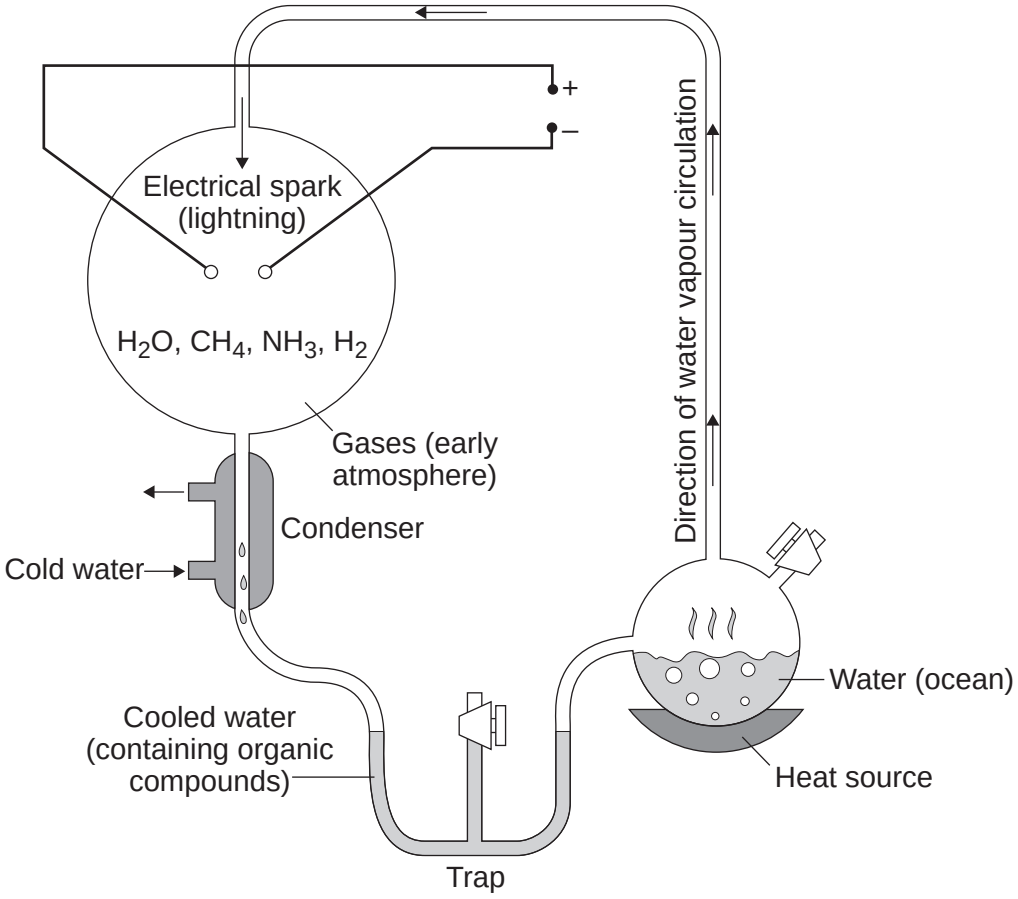
The simplest amino acid is glycine (aminoethanoic acid).



4.3.1.2 Relative formula mass

Question 23 · continued

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



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

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

Suggest why.

.....

.....

(1 mark)

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

Suggest **two** reasons why.

.....

.....

.....

.....

(2 marks)

5

4.3.1.2 Relative formula mass

Question 24

June 2012 | CH2HP | Original Q5 | Legacy

5 Aluminium is extracted from aluminium oxide.

5 (a) The formula of aluminium oxide is Al_2O_3

The relative formula mass (M_r) of aluminium oxide is 102.

Calculate the percentage of aluminium in aluminium oxide.

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

.....

.....

.....

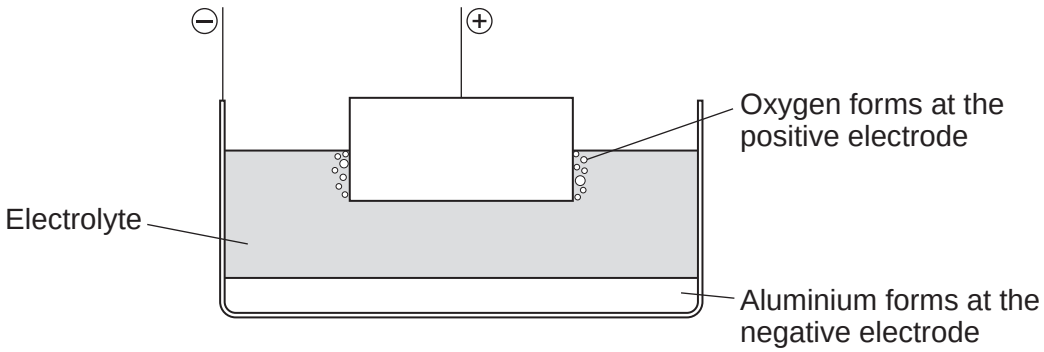
.....

Percentage of aluminium = ... %

(2 marks)

5 (b) Aluminium is extracted from aluminium oxide using electrolysis.

The diagram shows a cell used for the extraction of aluminium.



4.3.1.2 Relative formula mass

Question 24 · continued

5 (b) (i) The electrolyte contains cryolite.

Explain why.

.....

.....

.....

.....

(2 marks)

5 (b) (ii) Oxygen is formed at the positive electrode. Complete and balance the equation for this reaction.

..... O^{2-} → O_2 + ...

(2 marks)

5 (b) (iii) The positive electrode in the cell is used up during the process.

Explain why.

.....

.....

.....

.....

.....

.....

(2 marks)

8

4.3.1.2 Relative formula mass

Question 25

June 2013 | CH1HP | Original Q2 | Legacy

2 Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

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

Suggest **two** reasons why.

.....

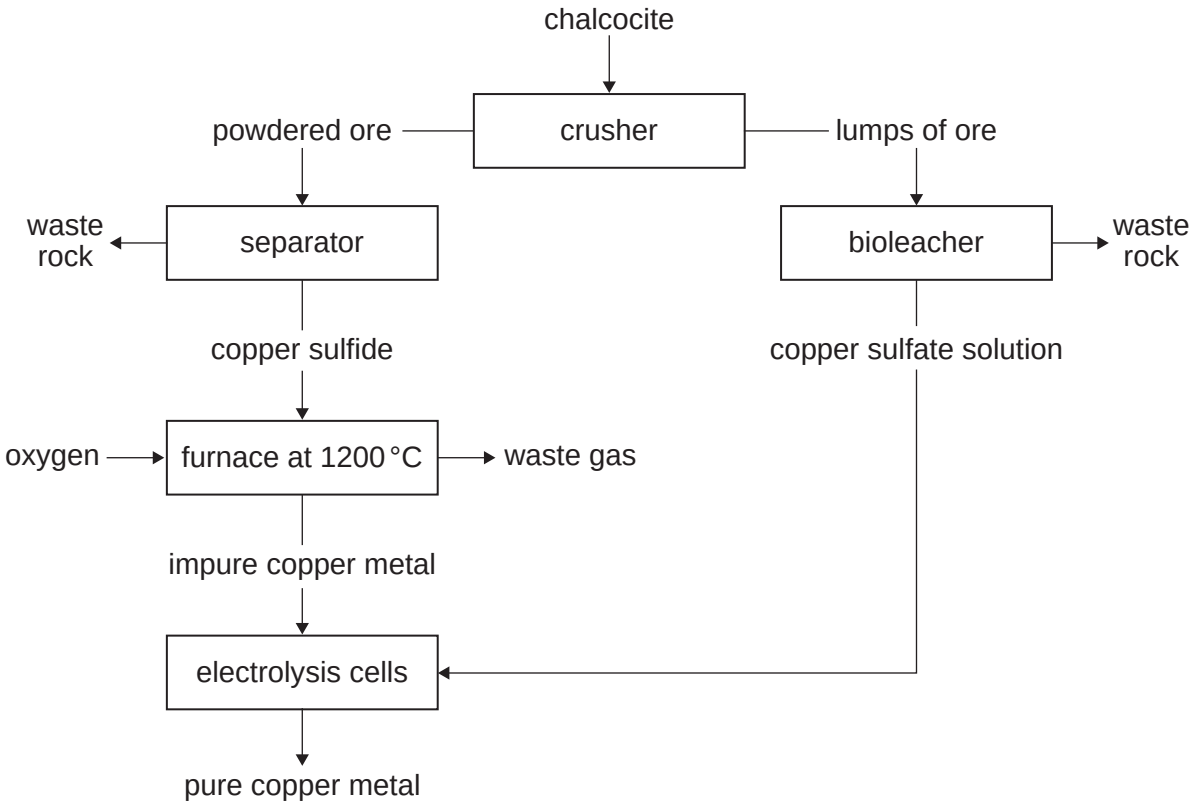
.....

.....

.....

(2 marks)

2 (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 25 · continued

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

.....

.....

(1 mark)

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

.....

.....

.....

.....

(2 marks)

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

.....

.....

(1 mark)

2 (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)

2 (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 26

June 2013 | CH1HP | Original Q5 | Legacy

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

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

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

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

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

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

(2 marks)

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

What is *locked up* carbon dioxide?

.....

.....

.....

.....

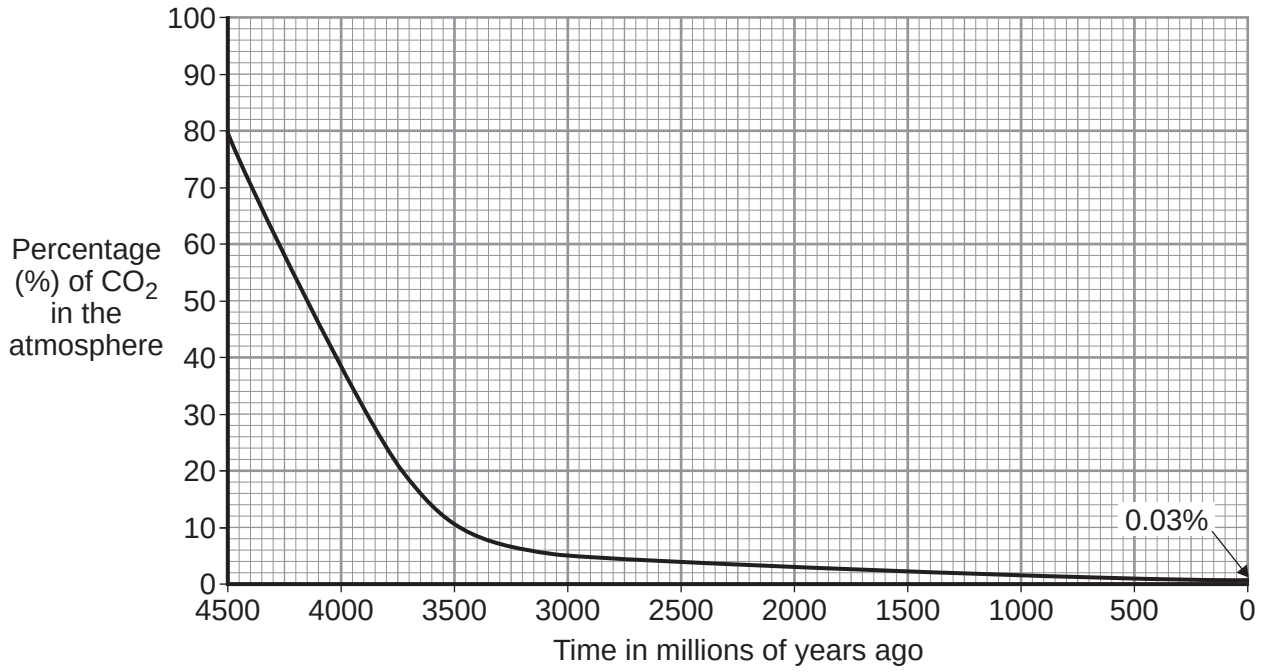
(2 marks)

4.3.1.2 Relative formula mass

Question 26 · continued

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

Graph 1



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

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

.....

.....

.....

.....

(2 marks)

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

.....

.....

.....

.....

(2 marks)

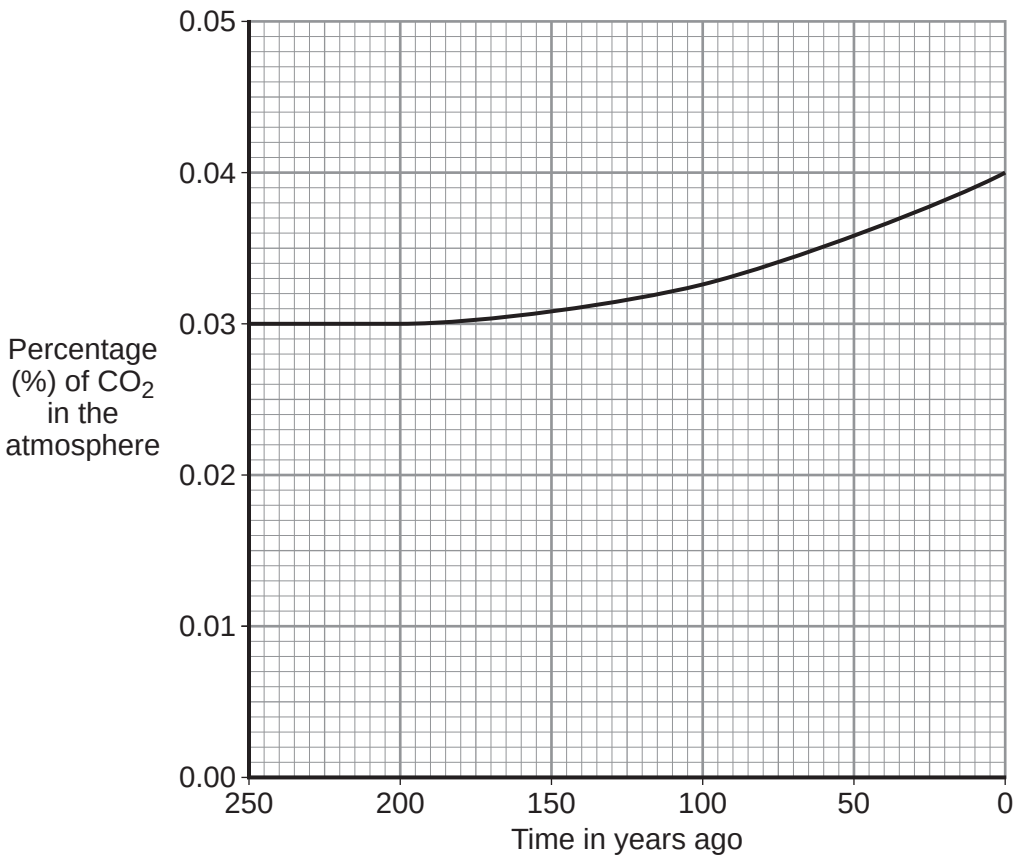
Question 5 continues on the next page

4.3.1.2 Relative formula mass

Question 26 · continued

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

Graph 2



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

Explain your answer.

.....

.....

.....

.....

(2 marks)

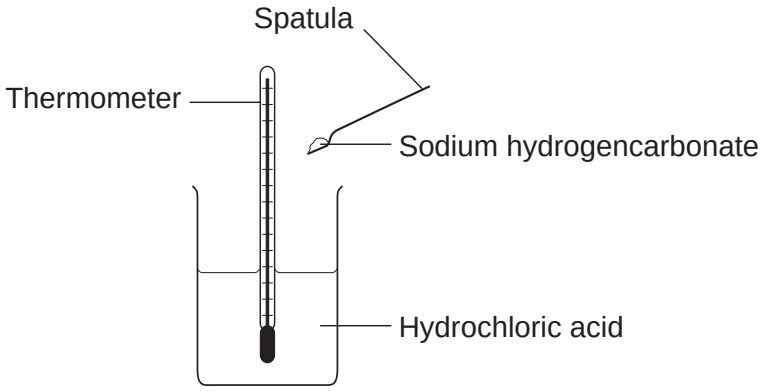
10

4.3.1.2 Relative formula mass

Question 27

June 2013 | CH2HP | Original Q1 | Legacy

1 (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 27 · continued

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

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

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

.....

.....

(1 mark)

Question 1 continues on the next page

4.3.1.2 Relative formula mass

Question 27 · continued

1 (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:

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

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



Use the equation to suggest why.

.....

.....

(1 mark)

1 (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 27 · continued

1 (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)

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

.....

.....

Percentage of carbon = ... %

(1 mark)

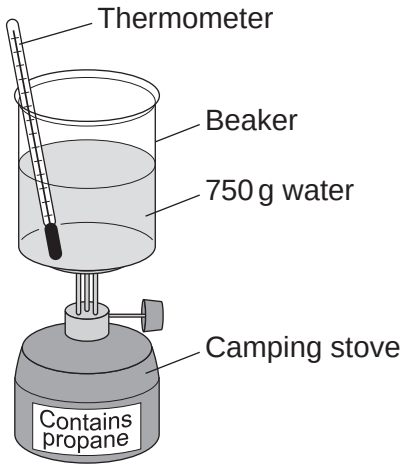
9

4.3.1.2 Relative formula mass

Question 28

June 2013 | CH3HP | Original Q7 | Legacy

7 A camping stove uses propane gas.



7 (a) A student did an experiment to find the energy released when propane is burned.

The student:

- put 750 g water into a beaker
- measured the temperature of the water, which was 17 °C
- heated the water by burning propane
- measured the temperature of the water again, which was then 64 °C.

The student calculated the energy released using the equation

$$Q = m \times 4.2 \times \Delta T$$

Where:
Q = energy released (J)
m = mass of water (g)
ΔT = temperature change (°C)

7 (a) (i) Use the student's results to calculate the energy released in joules (J).

.....

.....

.....

.....

.....

Energy released = ... J

(3 marks)

4.3.1.2 Relative formula mass

Question 28 · continued

7 (a) (ii) To find how much propane had been used the student weighed the camping stove before and after the experiment. The mass of the camping stove decreased by 6.0 g.

Using this information and your answer to part **7(a)(i)**, calculate the energy in kJ released when 1 mole of propane burns.

(If you have no answer for part **7(a)(i)**, assume the energy released during the experiment is 144 000 J. This is **not** the answer to part **7(a)(i)**.)

Relative formula mass (M_r) of propane = 44.

.....

.....

.....

.....

Energy released = ... kJ

(2 marks)

7 (a) (iii) Suggest **two** things the student could do to make his results more accurate.

.....

.....

.....

.....

(2 marks)

7 (a) (iv) The student's method does **not** give accurate results.

However, this method is suitable for comparing the energy released by different fuels.

Suggest why.

.....

.....

(1 mark)

Question 7 continues on the next page

4.3.1.2 Relative formula mass

Question 28 · continued

7 (b) The student used bond energies to calculate the energy released when propane is burned.

The equation for the combustion of propane is:

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

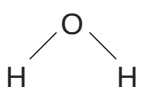
Some bond energies are given in the table.

Bond	Bond Energy in kJ per mole
C ═ O	803
O — H	464

The displayed structures of the products are:

carbon dioxide O ═ C ═ O

water



4.3.1.2 Relative formula mass

Question 28 · continued June 2013 | CH3HP | Original Q7 | Legacy

7 (b) (i) Calculate the energy released by bond making when the products are formed.

.....

.....

.....

.....

.....

Energy released = ... kJ per mole
(3 marks)

7 (b) (ii) The energy used for bond breaking of the reactants in the equation is 6481 kJ per mole.

Calculate the overall energy change of this reaction.

.....

.....

Overall energy change = ... kJ per mole
(1 mark)

12

4.3.1.2 Relative formula mass

Question 29

June 2015 | CH2HP | Original Q4 | Legacy

4 This question is about atoms and isotopes.

4 (a) Atoms contain protons, neutrons and electrons.
A lithium atom has the symbol $^{7}_{3}\text{Li}$

Explain, in terms of sub-atomic particles, why the mass number of this lithium atom is 7.

[3 marks]

.....

.....

.....

.....

.....

.....

4 (b) Amounts of substances can be described in different ways.

Complete the sentences.

[2 marks]

One mole of a substance is the relative formula mass in ..... .

The relative atomic mass of an element compares the mass of an atom of an element with the mass of an atom of ..... .

4 (c) Two isotopes of oxygen are $^{18}_{8}\text{O}$ and $^{16}_{8}\text{O}$

Describe the similarities and differences between the isotopes $^{18}_{8}\text{O}$ and $^{16}_{8}\text{O}$
You should refer to the numbers of sub-atomic particles in each isotope.

[3 marks]

.....

.....

.....

.....

.....

.....

8

4.3.1.2 Relative formula mass

Question 30

June 2016 | CH2HP | Original Q2 | Legacy

2 This question is about ammonia and fertilisers.

2 (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 _____ .

2 (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 30 · continued

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

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

[1 mark]

pH _____

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

[1 mark]

Tick (✓) **one** box.

$H^+ + OH^- \longrightarrow H_2O$ ☐

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

$H^+ + Cl^- \longrightarrow HCl$ ☐

$H^+ + H_2O \longrightarrow H_3O^+$ ☐

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

[1 mark]

_____

Question 2 continues on the next page

Question 30 · continued

2 (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.

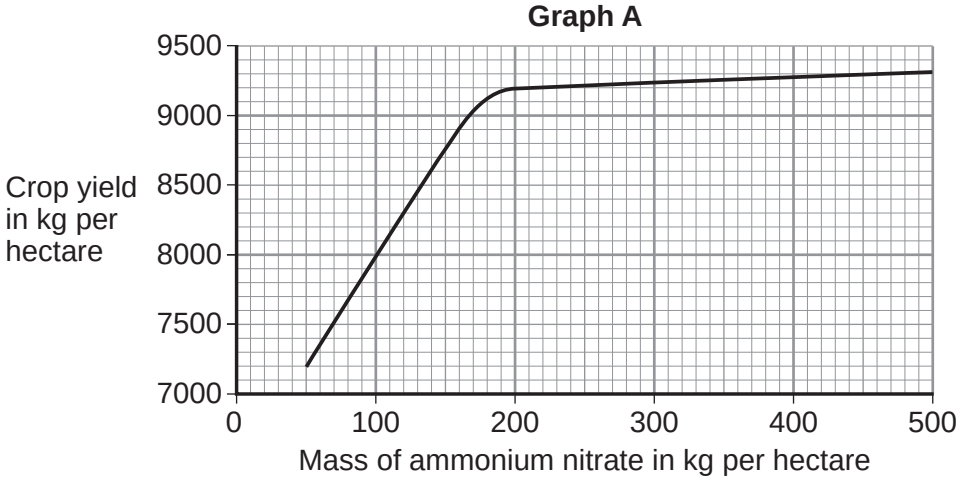
Rainwater dissolves ammonium nitrate in the soil.

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

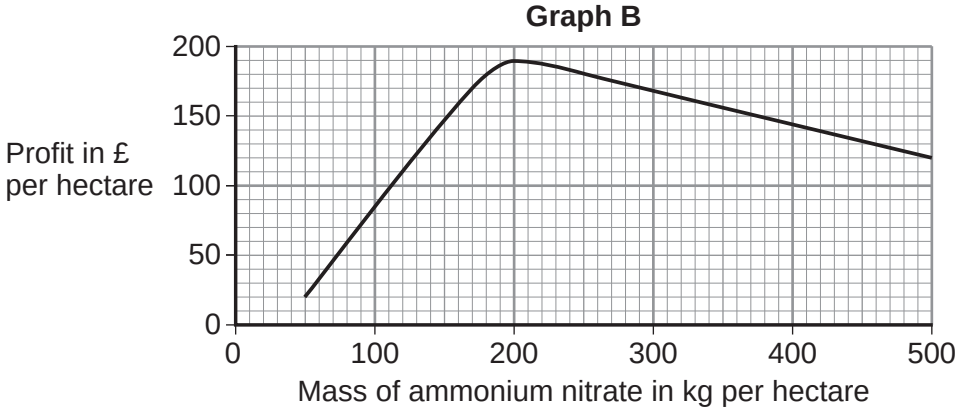
Figure 2 shows three graphs **A**, **B** and **C**. The graphs show information about the use of ammonium nitrate as a fertiliser. A hectare is a measurement of an area of land.

Figure 2

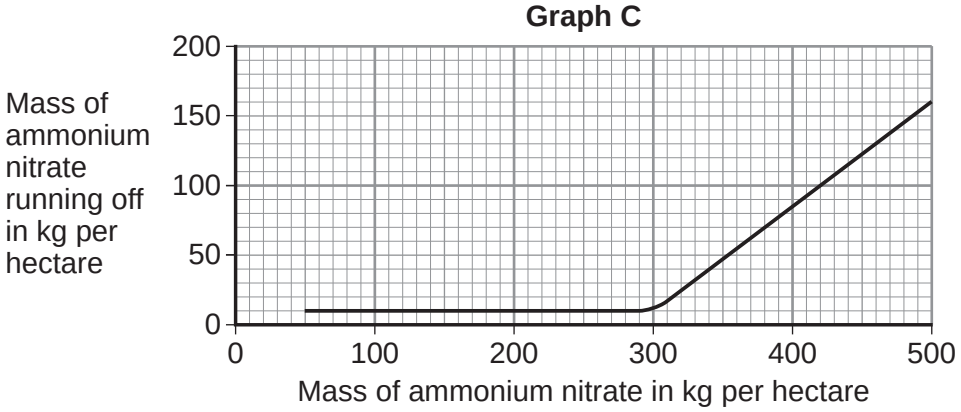
Graph A



Graph B



Graph C



4.3.1.2 Relative formula mass

Question 30 · 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 31

June 2017 | CH1HP | Original Q5 | Legacy

5 This question is about the Earth's atmosphere.

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

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

Table 4

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

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

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

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

[1 mark]

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

[3 marks]

4.3.1.2 Relative formula mass

Question 31 · continued

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

Table 5

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

*freezes at this temperature

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

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

[1 mark]

_____ and _____

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

[1 mark]

_____

_____

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

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

[2 marks]

_____

_____

_____

_____

4.3.1.2 Relative formula mass

Question 31 · continued

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

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

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

Stage 1 pass oxygen into molten cast iron

Stage 2 add small amounts of other metals.

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

[4 marks]

12

4.3.1.2 Relative formula mass

Question 32

June 2017 | CH2HP | Original Q4 | Legacy

4 This question is about sulfuric acid (H_2SO_4) and ethene.

Sulfuric acid is used to produce copper sulfate ($CuSO_4$).

The equation for the reaction is:

$$CuO(s) + H_2SO_4(aq) \longrightarrow CuSO_4(aq) + H_2O(l)$$

4 (a) Describe a method for making copper sulfate crystals from copper oxide and sulfuric acid.

[4 marks]

4 (b) Calculate the mass of copper oxide required to produce 24.95 g of copper sulfate crystals ($CuSO_4.5H_2O$).

Relative formula mass (M_r) of copper sulfate crystals = 249.5

Relative atomic masses (A_r): O = 16; Cu = 63.5

[3 marks]

Mass of copper oxide = _____ g

4.3.1.2 Relative formula mass

Question 32 · continued

4 (c) Ethene and sulfuric acid are used to make many substances.

4 (c) (i) **Table 1** shows data about wealth of countries, ethene production and sulfuric acid production.

Table 1

Country	Wealth of country in billions of dollars	Ethene production in kilotonnes	Sulfuric acid production in kilotonnes
A	4000	13 900	36 000
B	1300	4 400	6 600
C	1290	2 700	26 000
D	620	3 100	2 500
E	460	1 500	4 200
F	310	650	6 700

How does the wealth of countries relate to their production of ethene and sulfuric acid?

[2 marks]

4 (c) (ii) Suggest why the use of ethene has increased in the last 50 years.

[1 mark]

10

4.3.1.2 Relative formula mass

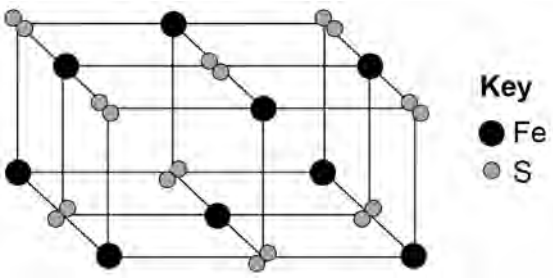
Question 33

0 2 This question is about metals and metal compounds.

0 2 . 1 Iron pyrites is an ionic compound.

Figure 1 shows a structure for iron pyrites.

Figure 1



Determine the formula of iron pyrites.

Use **Figure 1**.

[1 mark]

_____

0 2 . 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 2 . 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 33 · continued

Nickel is extracted from nickel oxide by reduction with carbon.

0 2 . 4 Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

0 2 . 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 34

June 2018 | 8462/1H | Original Q9

0 9 This question is about acids and alkalis.

0 9 . 1 Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

[2 marks]

0 9 . 2 A 1.0×10^{-3} mol/dm^3 solution of hydrochloric acid has a pH of 3.0

What is the pH of a 1.0×10^{-5} mol/dm^3 solution of hydrochloric acid?

[1 mark]

pH = _____

Question 9 continues on the next page

4.3.1.2 Relative formula mass

Question 34 · continued

A student titrated 25.0 cm^3 portions of dilute sulfuric acid with a 0.105 mol/dm^3 sodium hydroxide solution.

0 9 . 3 **Table 4** shows the student's results.

Table 4

	Titration 1	Titration 2	Titration 3	Titration 4	Titration 5
Volume of sodium hydroxide solution in cm^3	23.50	21.10	22.10	22.15	22.15

The equation for the reaction is:

$$2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2\ H_2O$$

Calculate the concentration of the sulfuric acid in mol/dm^3

Use only the student's concordant results.

Concordant results are those within 0.10 cm^3 of each other.

[5 marks]

Concentration of sulfuric acid = _____ mol/dm^3

4.3.1.2 Relative formula mass

Question 34 · continued

0 9 . 4 Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

[2 marks]

0 9 . 5 Calculate the mass of sodium hydroxide in 30.0 cm^3 of a 0.105 mol/dm^3 solution.

Relative formula mass (M_r): NaOH = 40

[2 marks]

Mass of sodium hydroxide = _____ g

12

4.3.1.2 Relative formula mass

Question 35

June 2018 | 8462/2H | Original Q2

0 2 Methylated spirit is a useful product made from a mixture of substances.

Table 1 shows the mass of the substances in a sample of methylated spirit.

Table 1

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

0 2 . 1 What name is given to a useful product such as methylated spirit?

[1 mark]

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

Use **Table 1**.

[2 marks]

Percentage = _____ %

Question 2 continues on the next page

4.3.1.2 Relative formula mass

Question 35 · 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 2 . 3 Suggest why pyridine and methyl violet are added to ethanol to make methylated spirit.

[1 mark]

0 2 . 4 Suggest **one** use of methylated spirit.

[1 mark]

0 2 . 5 Describe how ethanol is produced from sugar solution.

Give the name of this process.

[3 marks]

4.3.1.2 Relative formula mass

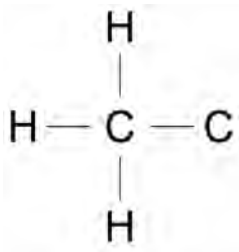
Question 35 · continued

0 2 . 6 **Figure 2** shows part of the displayed formula for ethanol.

Complete **Figure 2**.

[1 mark]

Figure 2



0 2 . 7 Name the gas produced when sodium is added to ethanol.

[1 mark]

0 2 . 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 36

June 2018 | 8462/2H | Original Q7

0 7 Older cars are tested each year to measure the amount of pollutants contained in exhaust fumes.

Table 4 shows the maximum allowed percentages of exhaust pollutants for petrol cars.

Table 4

Age of car in years	Maximum allowed percentage (%) of exhaust pollutant	
	Carbon monoxide	Unburned hydrocarbons
16–24	0.30	0.02
3–16	0.20	0.02

0 7 . 1 Explain how carbon monoxide is produced when petrol is burned in car engines.

[2 marks]

0 7 . 2 Suggest **two** reasons why the maximum allowed percentage of carbon monoxide has been decreased for newer cars.

[2 marks]

1

2

4.3.1.2 Relative formula mass

Question 36 · continued

0 7 . 3 Give **one** reason for having a maximum allowed percentage of unburned hydrocarbons in exhaust fumes.

[1 mark]

Oxides of nitrogen are also pollutants contained in exhaust fumes.

0 7 . 4 Describe how oxides of nitrogen are produced when petrol is burned in car engines.

[2 marks]

Catalytic converters are fitted to car exhausts to reduce the amount of pollutants released into the atmosphere.

0 7 . 5 Nitrogen dioxide is an oxide of nitrogen.

Nitrogen dioxide reacts to produce nitrogen and oxygen in catalytic converters.

Complete the equation for this reaction.

The equation should be balanced.

[2 marks]

$$___\ NO_2\ (g) \rightarrow _____ + ___\ O_2\ (g)$$

4.3.1.2 Relative formula mass

Question 36 · continued

0 7 . 6 Give **two** effects of atmospheric pollution which are reduced by using catalytic converters.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 7 The catalyst in catalytic converters is a mixture of three elements.

Where in the periodic table are these elements most likely to be found?

[1 mark]

Tick **one** box.

- Alkali metals ☐
- Halogens ☐
- Noble gases ☐
- Transition metals ☐

12

4.3.1.2 Relative formula mass

Question 37

June 2019 | 8462/1H | Original Q7

0 7 This question is about electrolysis.

Aluminium is produced by electrolysing a molten mixture of aluminium oxide and cryolite.

0 7 . 1 Explain why a mixture is used as the electrolyte instead of using only aluminium oxide.

[2 marks]

0 7 . 2 What happens at the negative electrode during the production of aluminium?

[1 mark]

Tick (✓) **one** box.

- Aluminium atoms gain electrons. ☐
- Aluminium atoms lose electrons. ☐
- Aluminium ions gain electrons. ☐
- Aluminium ions lose electrons. ☐

0 7 . 3 Oxygen is produced at the positive electrode.

Complete the balanced half-equation for the process at the positive electrode.

[2 marks]

$\rightarrow \quad O_2 \quad +$

4.3.1.2 Relative formula mass

Question 37 · continued

0 7 . 4 Explain why the positive electrode must be continually replaced.

[3 marks]

0 7 . 5 The overall equation for the electrolysis of aluminium oxide is:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed.

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

[4 marks]

Mass of oxygen = _____ kg

4.3.1.2 Relative formula mass

Question 37 · continued

Sodium metal and chlorine gas are produced by the electrolysis of molten sodium chloride.

0 7 . 6 Explain why sodium chloride solution **cannot** be used as the electrolyte to produce sodium metal.

[2 marks]

0 7 . 7 Calculate the volume of 150 kg of chlorine gas at room temperature and pressure.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Relative formula mass (M_r): Cl_2 = 71

[2 marks]

Volume = _____ dm^3

16

4.3.1.2 Relative formula mass

Question 38

June 2019 | 8462/2H | Original Q2

0 2 This question is about lithium carbonate.

Lithium carbonate is used in medicines.

Figure 2 shows a tablet containing lithium carbonate.

Figure 2



0 2 . 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 38 · continued

0 2 . 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 2 . 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 39

November 2020 | 8462/1H | Original Q3

0 3 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:

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

0 3 . 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 3 shows the student's results.

Table 3

	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 3** in your answer.

[2 marks]

4.3.1.2 Relative formula mass

Question 39 · continued

0 3 . 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.

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

[1 mark]

0 3 . 4 Suggest why the student warmed the silver iodide.

[1 mark]

Question 3 continues on the next page

4.3.1.2 Relative formula mass

Question 39 · continued

0 3 . 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) = _____ %

0 3 . 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 40

November 2021 | 8462/1H | Original Q3

0 3 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:

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

0 3 . 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** = _____

0 3 . 2 Identify element **R**.

You should use:

- your answer to **question 03.1**
- the periodic table.

[1 mark]

Identity of **R** = _____

4.3.1.2 Relative formula mass

Question 40 · continued

0 3 . 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 3 continues on the next page

4.3.1.2 Relative formula mass

Question 40 · continued

0 3 . 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 2 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 2

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 41

November 2021 | 8462/1H | Original Q9

0 9 This question is about acids.

Hydrogen chloride and ethanoic acid both dissolve in water.

All hydrogen chloride molecules ionise in water.

Approximately 1% of ethanoic acid molecules ionise in water.

0 9 . 1 A solution is made by dissolving 1 g of hydrogen chloride in 1 dm^3 of water.

Which is the correct description of this solution?

[1 mark]

Tick (✓) **one** box.

- A concentrated solution of a strong acid ☐
- A concentrated solution of a weak acid ☐
- A dilute solution of a strong acid ☐
- A dilute solution of a weak acid ☐

0 9 . 2 Which solution would have the lowest pH?

[1 mark]

Tick (✓) **one** box.

- 0.1 mol/dm^3 ethanoic acid solution ☐
- 0.1 mol/dm^3 hydrogen chloride solution ☐
- 1.0 mol/dm^3 ethanoic acid solution ☐
- 1.0 mol/dm^3 hydrogen chloride solution ☐

4.3.1.2 Relative formula mass

Question 41 · continued

A student investigated the concentration of a solution of sodium hydroxide by titration with a 0.0480 mol/dm^3 ethanedioic acid solution.

This is the method used.

1. Measure 25.0 cm^3 of the sodium hydroxide solution into a conical flask using a 25.0 cm^3 pipette.
2. Add two drops of indicator to the sodium hydroxide solution.
3. Fill a burette with the 0.0480 mol/dm^3 ethanedioic acid solution to the 0.00 cm^3 mark.
4. Add the ethanedioic acid solution to the sodium hydroxide solution until the indicator changes colour.
5. Read the burette to find the volume of the ethanedioic acid solution used.

0 9 . 3 Suggest **two** improvements to the method that would increase the accuracy of the result.

[2 marks]

1 _____

_____

2 _____

_____

Question 9 continues on the next page

4.3.1.2 Relative formula mass

Question 41 · continued

0 9 . 4 Ethanedioic acid is a solid at room temperature.

Calculate the mass of ethanedioic acid ($H_2C_2O_4$) needed to make 250 cm^3 of a solution with concentration 0.0480 mol/dm^3

Relative formula mass (M_r): $H_2C_2O_4 = 90$

[2 marks]

Mass = _____ g

0 9 . 5 The student found that 25.0 cm^3 of the sodium hydroxide solution was neutralised by 15.00 cm^3 of the 0.0480 mol/dm^3 ethanedioic acid solution.

The equation for the reaction is:

$$H_2C_2O_4 + 2\,NaOH \rightarrow Na_2C_2O_4 + 2\,H_2O$$

Calculate the concentration of the sodium hydroxide solution in mol/dm^3

[3 marks]

Concentration = _____ mol/dm^3

9

4.3.1.2 Relative formula mass

Question 42

November 2021 | 8462/2H | Original Q6

0 6 This question is about cycloalkenes.

Cycloalkenes are ring-shaped hydrocarbon molecules containing a double carbon-carbon bond.

Cycloalkenes react in a similar way to alkenes.

0 6 . 1 Describe a test for the double carbon-carbon bond in cycloalkene molecules.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 6 . 2 **Table 3** shows the name and formula of three cycloalkenes.

Table 3

Name	Formula
Cyclobutene	C_4H_6
Cyclopentene	C_5H_8
Cyclohexene	C_6H_{10}

Determine the general formula for cycloalkenes.

[1 mark]

_____

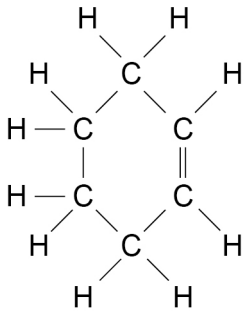
General formula = _____

4.3.1.2 Relative formula mass

Question 42 · continued

Figure 6 shows the displayed structural formula of cyclohexene, C_6H_{10}

Figure 6

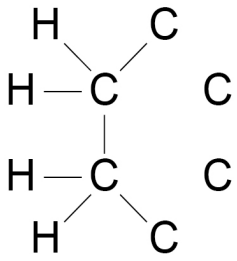


Chlorine reacts with cyclohexene to produce a compound with the formula $C_6H_{10}Cl_2$

0 6 . 3 Complete **Figure 7** to show the displayed structural formula of $C_6H_{10}Cl_2$

[2 marks]

Figure 7



0 6 . 4 Calculate the percentage by mass of chlorine in a molecule of $C_6H_{10}Cl_2$

Relative atomic masses (A_r): H = 1 C = 12 Cl = 35.5

[3 marks]

Percentage by mass = _____ %

8

4.3.1.2 Relative formula mass

Question 43

June 2023 | 8462/2H | Original Q5

0 5 Copper is extracted from metal ores.

Chalcopyrite is a metal ore containing a compound with the formula $CuFeS_2$

0 5 . 1 $CuFeS_2$ reacts with oxygen to produce copper(II) sulfate and iron(II) sulfate.

Complete the equation for this reaction.

You should balance the equation.

[2 marks]

$$CuFeS_2 + _____ \rightarrow CuSO_4 + FeSO_4$$

0 5 . 2 Calculate the percentage by mass of copper in $CuFeS_2$

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

[3 marks]

Percentage by mass = _____ %

0 5 . 3 Describe a test to show the presence of copper(II) ions in a solution of copper(II) sulfate.

Give the result of the test.

[2 marks]

Test _____

Result _____

4.3.1.2 Relative formula mass

Question 43 · continued

0 5 . 4 Copper can be extracted from low-grade ores by bioleaching.

Describe what is meant by bioleaching.

[2 marks]

9

Turn over for the next question

4.3.1.2 Relative formula mass

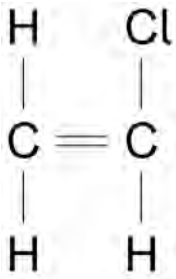
Question 44

June 2023 | 8462/2H | Original Q8

0 8 This question is about polymers.

Chloroethene can be used to produce an addition polymer called poly(chloroethene).

The displayed structural formula of chloroethene is

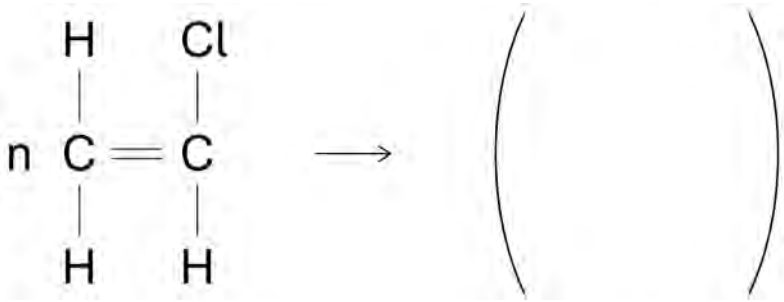


0 8 . 1 Draw a circle around the functional group on the displayed structural formula that allows chloroethene to produce an addition polymer.

[1 mark]

0 8 . 2 Complete the equation for the production of poly(chloroethene) from chloroethene.

[3 marks]



0 8 . 3 Poly(ethene) can be strengthened with wood particles to make a building material.

The building material consists of a wood particle reinforcement embedded in a poly(ethene) matrix.

What general name is given to materials like this?

[1 mark]

4.3.1.2 Relative formula mass

Question 44 · continued

0 8 . 4 The amino acid beta-alanine has the formula

$H_2NCH_2CH_2COOH$

Beta-alanine polymerises to produce a polypeptide and a small molecule.

Name the small molecule produced when beta-alanine polymerises.

[1 mark]

0 8 . 5 An amino acid can be represented as:



The relative formula mass (M_r) of this amino acid is 75

Calculate the relative formula mass of the section of this amino acid molecule represented by



Relative atomic masses (A_r): H = 1 C = 12 N = 14 O = 16

[2 marks]

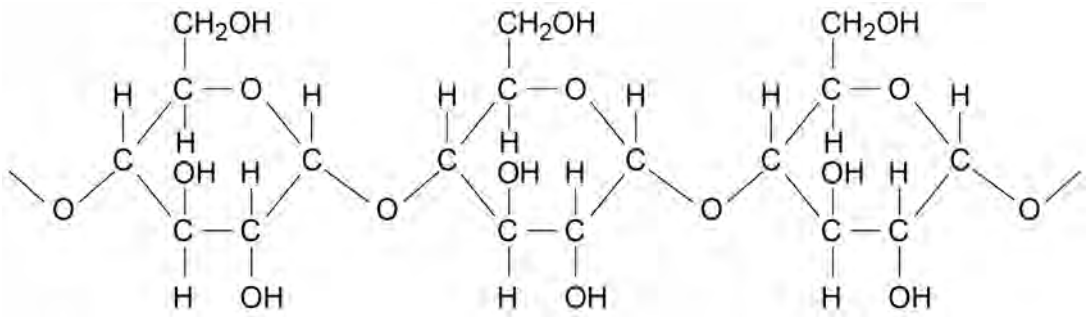
Relative formula mass = _____

4.3.1.2 Relative formula mass

Question 44 · continued

Figure 6 represents part of a naturally occurring polymer molecule produced from glucose.

Figure 6



0 8 . 6 Draw a circle around the repeating unit in the polymer in **Figure 6**.

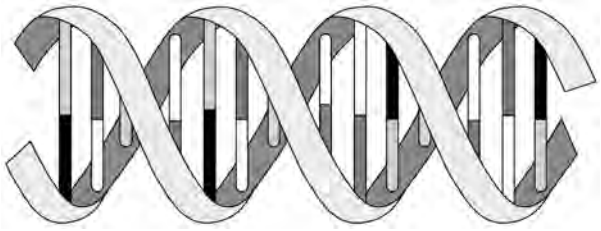
[1 mark]

0 8 . 7 Suggest the identity of this polymer.

[1 mark]

Figure 7 represents the structure of a naturally occurring polymer.

Figure 7



0 8 . 8 Give the general name for the four different monomers which make up the structure shown in **Figure 7**.

[1 mark]

0 8 . 9 Name the **shape** of the structure shown in **Figure 7**.

[1 mark]

12

4.3.1.2 Relative formula mass

Question 45

June 2024 | 8462/1H | Original Q7

0 7 This question is about iron.

0 7 . 1 Iron is a metal.

Describe how iron conducts thermal energy.

[2 marks]

0 7 . 2 Pure iron is too soft for many uses.

Explain why mixing iron with other metals makes alloys which are harder than pure iron.

[3 marks]

Question 7 continues on the next page

4.3.1.2 Relative formula mass

Question 45 · continued

0 7 . 3 When iron reacts with chlorine, 0.12 mol of iron reacts with 0.18 mol of chlorine (Cl_2).

Which is the correct equation for the reaction?

[1 mark]

Tick (✓) **one** box.

$Fe + Cl_2 \rightarrow FeCl_2$ ☐

$Fe + 3Cl_2 \rightarrow FeCl_6$ ☐

$2Fe + Cl_2 \rightarrow 2FeCl$ ☐

$2Fe + 3Cl_2 \rightarrow 2FeCl_3$ ☐

The most common oxides of iron are Fe_2O_3 and Fe_3O_4

0 7 . 4 What is the ratio of the numbers of ions in Fe_3O_4?

[1 mark]

Tick (✓) **one** box.

$2\ Fe^{2+} : 1\ Fe^{3+} : 4\ O^{2-}$ ☐

$1\ Fe^{2+} : 2\ Fe^{3+} : 4\ O^{2-}$ ☐

$3\ Fe^{2+} : 4\ O^{2-}$ ☐

$3\ Fe^{3+} : 4\ O^{2-}$ ☐

4.3.1.2 Relative formula mass

Question 45 · continued

0 7 . 5 Calculate the percentage (%) by mass of iron in Fe_3O_4

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

[3 marks]

Percentage by mass of iron = _____ %

0 7 . 6 Fe_2O_3 reacts with carbon to produce carbon dioxide.

The equation for the reaction is:

$$2\,Fe_2O_3(s) + 3\,C(s) \rightarrow 4\,Fe(s) + 3\,CO_2(g)$$

Calculate the volume of carbon dioxide gas at room temperature and pressure that is produced from 40.0 kg of Fe_2O_3 using excess carbon.

Relative formula mass (M_r): Fe_2O_3 = 160

The volume of 1 mole of any gas at room temperature and pressure is 24 dm^3.

[5 marks]

Volume of carbon dioxide = _____ dm^3

15

4.3.1.2 Relative formula mass

Question 46

June 2024 | 8462/2H | Original Q1

0 1 A student investigated an aqueous solution of a salt.

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

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

Give the result of the test.

[2 marks]

Test for sodium ions _____

_____

Result _____

_____

0 1 . 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 46 · 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 1 . 3 Why did the student heat the evaporating dish and contents until the mass did not change?

[1 mark]

0 1 . 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 1 continues on the next page

4.3.1.2 Relative formula mass

Question 46 · continued

0 1 . 5 The student calculated the concentration of sodium chloride in the salt solution.

Table 1 shows the results.

Table 1

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 47

June 2025 | 8462/1H | Original Q3

0 3 This question is about metals and metal oxides.

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

The equation for the reaction is:

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

0 3 . 1 Which substance is reduced in this reaction?

Give **one** reason for your answer.

Answer in terms of oxygen.

[2 marks]

Substance reduced _____

Reason _____

_____

0 3 . 2 Why can carbon be used to extract tin from tin oxide?

[1 mark]

_____

_____

Question 3 continues on the next page

4.3.1.2 Relative formula mass

Question 47 · continued

0 3 . 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 = _____ %

0 3 . 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 47 · continued

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

0 3 . 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]

0 3 . 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 48

June 2025 | 8462/1H | Original Q9

0 9 Zinc reacts with iodine to produce the salt zinc iodide.

The reaction is done in a solution using ethanol as the solvent.

Ethanol is a flammable liquid with a boiling point of 78 °C.

Table 5 shows the solubility of zinc, iodine and zinc iodide in ethanol.

Table 5

	Zinc	Iodine	Zinc iodide
Solubility in ethanol	Insoluble	Soluble	Soluble

0 9 . 1 Plan a method to obtain crystals of zinc iodide from zinc and iodine.

[6 marks]

Extra space

4.3.1.2 Relative formula mass

Question 48 · continued

0 9 . 2 A student used 6.35 g of iodine in the reaction.

6.29 g of zinc iodide was produced.

The equation for the reaction is:

$$Zn + I_2 \longrightarrow ZnI_2$$

Calculate the percentage yield of zinc iodide.

Give your answer to 3 significant figures.

Relative formula masses (M_r): $I_2 = 254$ $ZnI_2 = 319$

[5 marks]

Percentage yield (3 significant figures) = _____ %

11

4.3.1.2 Relative formula mass

Question 49

June 2025 | 8462/2H | Original Q4

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

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

[2 marks]

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

Table 4

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

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

Give **two** reasons why.

[2 marks]

1

2

4.3.1.2 Relative formula mass

Question 49 · continued

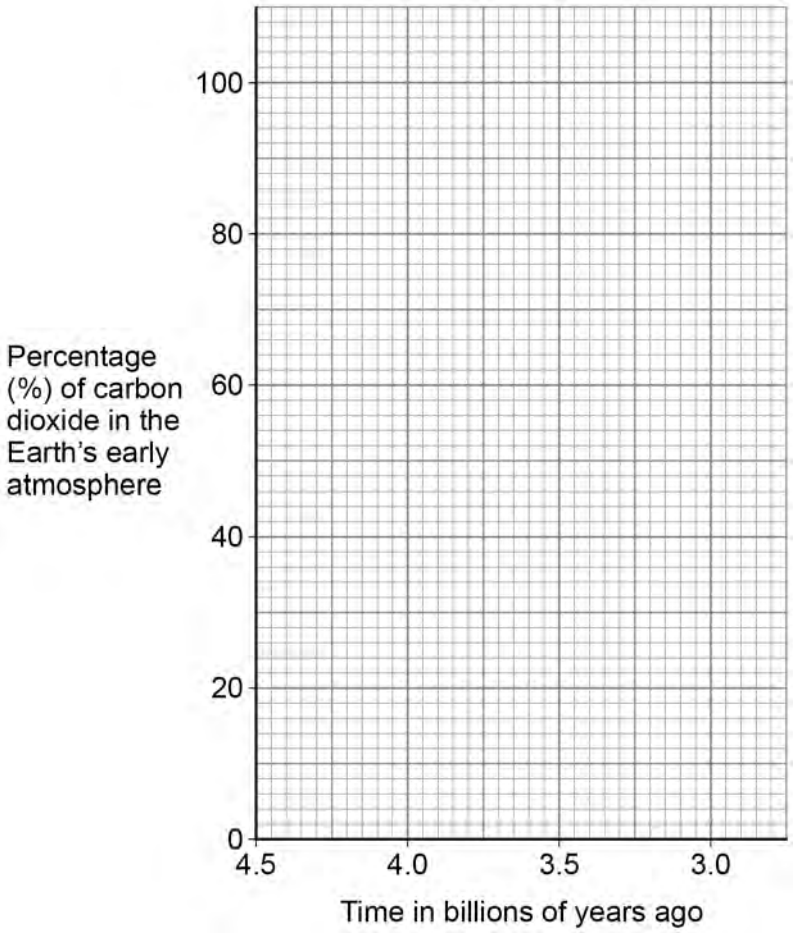
0 4 . 3 Complete **Figure 3**.

You should:

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

[2 marks]

Figure 3



Question 4 continues on the next page

4.3.1.2 Relative formula mass

Question 49 · continued

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

Table 5

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

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

Explain how.

[3 marks]

9