AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.1.1.6

Relative atomic mass

Past-paper questions

Tier	**Higher**
Question groups	**51**
Available paper years	**2008–2025**

Using this booklet

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

Name: _____ **Date:** _____

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

4.1.1.6 Relative atomic mass

Question 01

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.

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Percentage of nitrogen = ... %

(2 marks)

3

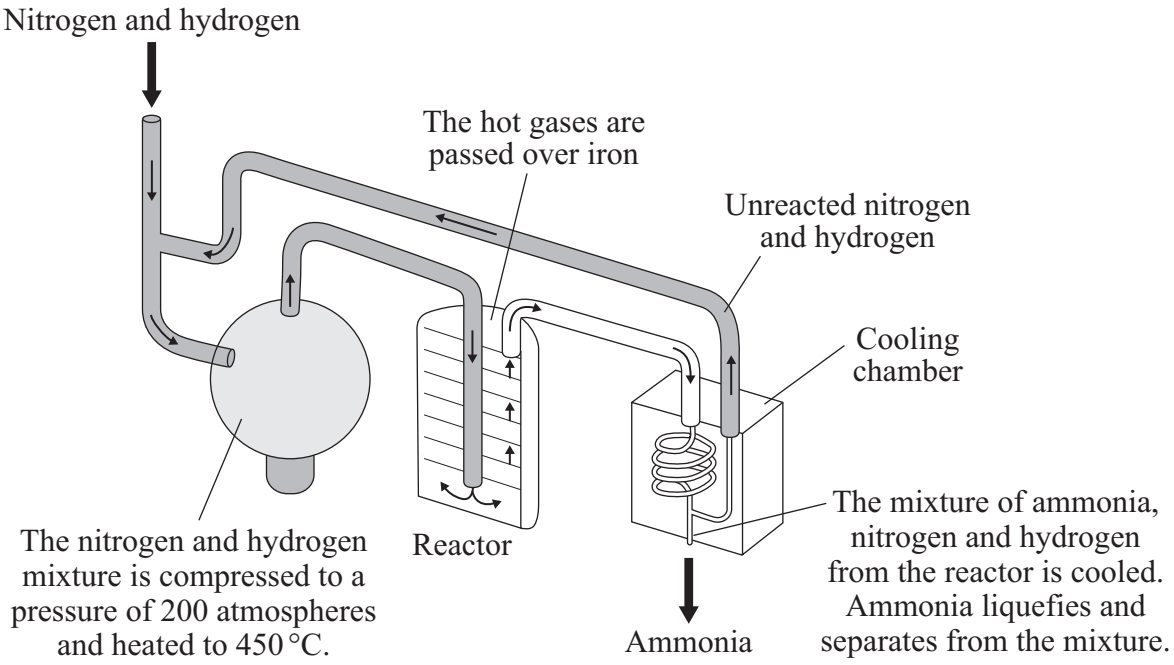
4.1.1.6 Relative atomic mass

Question 02

January 2008 | CHY2H | Original Q7 | Legacy

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

The diagram shows the main stages in the Haber process.



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

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

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

Relative atomic masses: H = 1; N = 14

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Mass .....g

(3 marks)

4.1.1.6 Relative atomic mass

Question 02 · continued

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

Calculate the percentage yield of ammonia produced in the reactor.

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

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Percentage yield of ammonia = ... %

(2 marks)

(c) State **and** explain:

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

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(2 marks)

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

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(2 marks)

Question 7 continues on the next page

4.1.1.6 Relative atomic mass

Question 02 · continued

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

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

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(3 marks)

12

4.1.1.6 Relative atomic mass

Question 03

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

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

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

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

4.1.1.6 Relative atomic mass

Question 03 · 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.

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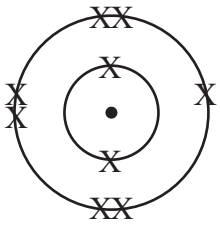
Mass of fluorine = ... g

(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^-.

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(2 marks)

7

4.1.1.6 Relative atomic mass

Question 04

June 2008 | CHY2H | Original Q5 | Legacy

5 Cosmetic powders were widely used in ancient Egypt.



Cosmetic powders that may have been used in face paints have been analysed. These powders contained compounds that are rare in nature. The compounds must have been made by the ancient Egyptians using chemical reactions.

4.1.1.6 Relative atomic mass

Question 04 · continued

for mark

5 (a) One of these compounds is called phosgenite.
Analysis of this compound shows that it contains:

76.0% lead (Pb) 13.0% chlorine (Cl) 2.2% carbon (C) 8.8% oxygen (O)

Calculate the empirical formula of this compound.

To gain full marks you must show all your working.

Relative atomic masses: C = 12 ; O = 16 ; Cl = 35.5 ; Pb = 207

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(4 marks)

5 (b) Another compound that the ancient Egyptians used is laurionite.

The reaction used to make laurionite can be represented by this equation:

$$PbO(s) + NaCl(aq) + H_2O(1) \rightarrow \underset{\text{laurionite}}{PbOHCl(s)} + NaOH(aq)$$

5 (b) (i) Explain why the pH of the solution increases as the reaction takes place.

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(1 mark)

5 (b) (ii) How could laurionite be separated from the other product when the reaction is complete?

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(1 mark)

6

4.1.1.6 Relative atomic mass

Question 05

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.

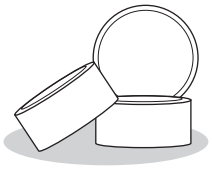
$$Cl_2(g) + H_2O(l) \rightleftharpoons 2H^+(aq) + OCl^-(aq) + Cl^-(aq)$$

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.

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

(2 marks)

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

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

(2 marks)

4.1.1.6 Relative atomic mass

Question 05 · continued

for mark

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

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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?

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(1 mark)

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

What is a *precipitate*?

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(1 mark)

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

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(1 mark)

9

4.1.1.6 Relative atomic mass

Question 06

June 2009 | CHY2H | Original Q6 | Legacy

6 Perfumes contain a mixture of chemicals.



The main ingredients of perfumes are a solvent and a mixture of fragrances.

6 (a) A sample of the solvent used in one perfume contained 0.60 g of carbon, 0.15 g of hydrogen and 0.40 g of oxygen.

Relative atomic masses: H = l; C = 12; O = 16.

Calculate the empirical (simplest) formula of the solvent.

You must show all of your working to gain full marks for this question.

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(4 marks)

4.1.1.6 Relative atomic mass

Question 06 · continued

for mark

6 (b) Solvent molecules evaporate easily.

Explain why substances made of simple molecules evaporate easily.

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(2 marks)

6 (c) Most companies claim that their perfumes have been tested on skin. A study was made of the tests they used. The study found that each company used different tests. The perfumes were tested in the companies' own laboratories and **not** by independent scientists.

Some companies did not give any information about the tests that they had used.

6 (c) (i) Suggest why companies test their perfumes on skin.

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(1 mark)

6 (c) (ii) Did the study show that the tests made by the different companies were valid and reliable?

Explain your answer.

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(2 marks)

9

4.1.1.6 Relative atomic mass

Question 07

January 2010 | CHY2H | Original Q3 | Legacy

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.

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Relative formula mass (M_r) = ...

(1 mark)

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

Explain why, in terms of molecules.

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(2 marks)

4.1.1.6 Relative atomic mass

Question 07 · 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.

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(2 marks)

6

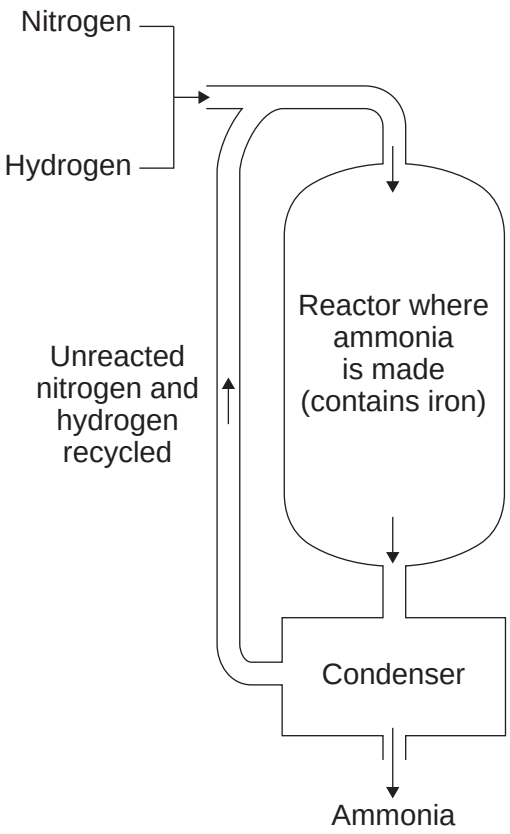
Turn over for the next question

4.1.1.6 Relative atomic mass

Question 08

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?

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(1 mark)

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

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(2 marks)

4.1.1.6 Relative atomic mass

Question 08 · 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

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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.

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Potassium nitrate is fertiliser ☐

(2 marks)

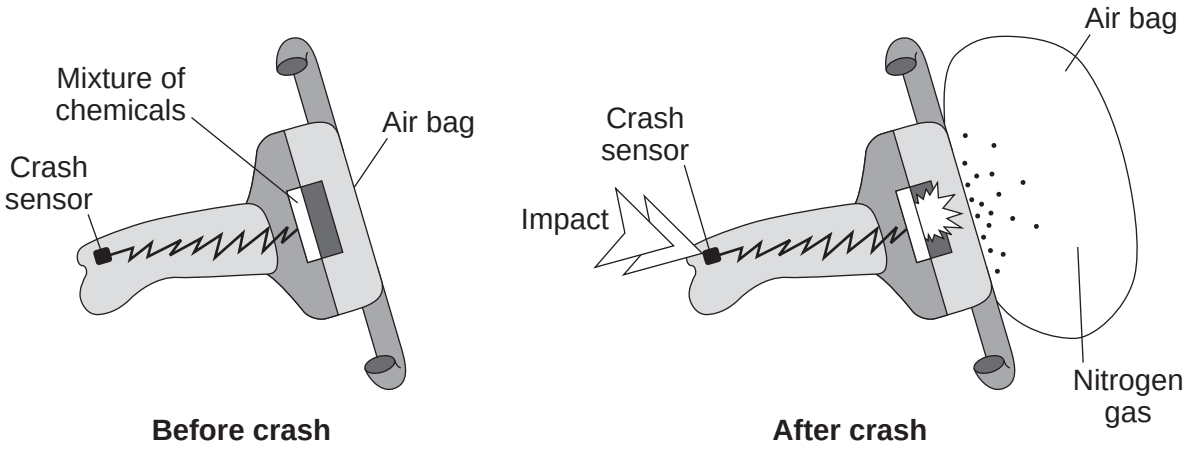
8

4.1.1.6 Relative atomic mass

Question 09

June 2010 | CHY2H | Original Q4 | Legacy

4 Air bags are used to protect the passengers in a car during an accident. When the crash sensor detects an impact it causes a mixture of chemicals to be heated to a high temperature. Reactions take place which produce nitrogen gas. The nitrogen fills the air bag.



Before crash **After crash**

4 (a) The mixture of chemicals contains sodium azide (NaN_3) which decomposes on heating to form sodium and nitrogen.

$$2NaN_3 \rightarrow 2Na + 3N_2$$

A typical air bag contains 130 g of sodium azide.

4 (a) (i) Calculate the mass of nitrogen that would be produced when 130 g of sodium azide decomposes.

Relative atomic masses (A_r): N = 14; Na = 23

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Mass of nitrogen = ... g

(3 marks)

4.1.1.6 Relative atomic mass

Question 09 · continued

4 (a) (ii) 1 g of nitrogen has a volume of 0.86 litres at room temperature and pressure.

What volume of nitrogen would be produced from 130 g of sodium azide?

(If you did not answer part (a)(i), assume that the mass of nitrogen produced from 130 g of sodium azide is 80 g. This is **not** the correct answer to part (a)(i).)

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Volume = ... litres

(1 mark)

4 (b) The sodium produced when the sodium azide decomposes is dangerous.
The mixture of chemicals contains potassium nitrate and silicon dioxide which help to make the sodium safe.

4 (b) (i) Sodium reacts with potassium nitrate to make sodium oxide, potassium oxide and nitrogen. Complete the balancing of the equation for this reaction.

$$10Na + ...KNO_3 \rightarrow .....Na_2O + K_2O + N_2$$

(1 mark)

4 (b) (ii) The silicon dioxide reacts with the sodium oxide and potassium oxide to form silicates.

Suggest why sodium oxide and potassium oxide are dangerous in contact with the skin.

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(1 mark)

6

4.1.1.6 Relative atomic mass

Question 10

January 2011 | CHY2H | Original Q2 | Legacy

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.

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.....

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)

4.1.1.6 Relative atomic mass

Question 10 · 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+}).

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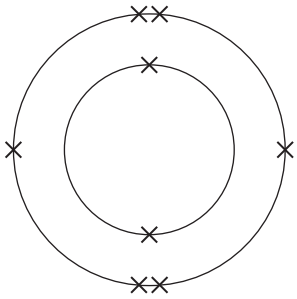
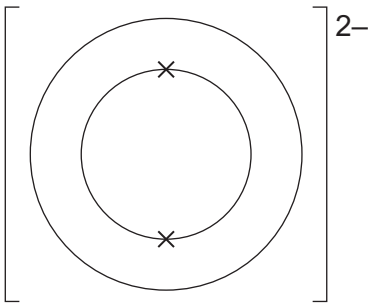
(2 marks)

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)

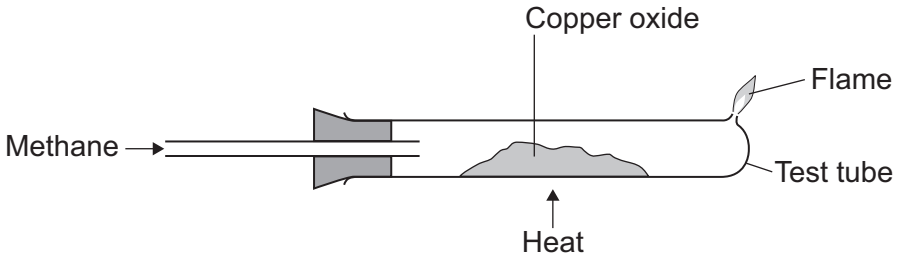
6

4.1.1.6 Relative atomic mass

Question 11

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.

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(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.

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Relative formula mass (M_r) = ...

(2 marks)

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

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Percentage of copper = ... %

(2 marks)

4.1.1.6 Relative atomic mass

Question 11 · continued

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

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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.

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Mean mass of copper made = ... g

(1 mark)

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

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(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 .....

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2 .....

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(2 marks)

10

4.1.1.6 Relative atomic mass

Question 12

June 2011 | CHY2H | Original Q6 | Legacy

6 Lead compounds have been used for thousands of years as colours in paint.



6 (a) A sample of a red oxide used in paint was found to contain 6.21 g of lead and 0.64 g of oxygen.

Calculate the empirical (simplest) formula of this compound.

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

Relative atomic masses: O = 16; Pb = 207.

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(4 marks)

4.1.1.6 Relative atomic mass

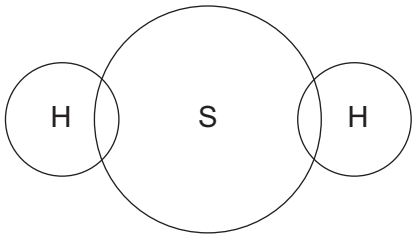
Question 12 · continued June 2011 | CHY2H | Original Q6 | Legacy

6 (b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.

6 (b) (i) Hydrogen sulfide has the formula H_2S. The bonding in a molecule of hydrogen sulfide can be represented as:

H–S–H

Complete the diagram below to show the arrangement of the outer electrons of the hydrogen and sulfur atoms in hydrogen sulfide.
Use dots (•) and crosses (x) to represent the electrons.
You need only show the outer shell electrons.
(Atomic numbers: H = 1; S = 16.)



(1 mark)

6 (b) (ii) Hydrogen sulfide has a low boiling point.

Explain why.

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(2 marks)

6 (b) (iii) Lead white is also used in paint. The white colour slowly darkens when lead sulfide is produced.

The painting can be restored with hydrogen peroxide. This converts the black lead sulfide into white lead sulfate.

Balance the equation for the reaction between lead sulfide and hydrogen peroxide (H_2O_2).

$$PbS(s) + ...H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$$

(1 mark)

8

4.1.1.6 Relative atomic mass

Question 13

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.

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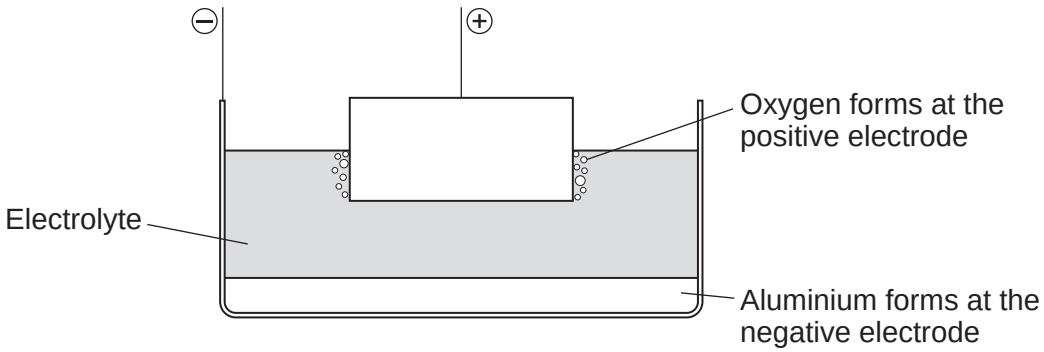
Percentage of aluminium = ... %

(2 marks)

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

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



4.1.1.6 Relative atomic mass

Question 13 · continued

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

Explain why.

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(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.

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(2 marks)

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4.1.1.6 Relative atomic mass

Question 14

June 2012 | CH2HP | Original Q6 | Legacy

6 This question is about calcium hydroxide.

Ancient artworks and monuments can be protected from acid rain if the surface is sprayed with calcium hydroxide nanoparticles.



6 (a) Calcium hydroxide has the formula $Ca(OH)_2$

Why are there two hydroxide ions for each calcium ion in the formula?

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(1 mark)

6 (b) The calcium hydroxide is used in the form of *nanoparticles*.

What are *nanoparticles*?

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(1 mark)

4.1.1.6 Relative atomic mass

Question 14 · continued

6 (c) A student added water to calcium oxide to make calcium hydroxide.

The equation for the reaction is shown below.

$$CaO + H_2O \rightarrow Ca(OH)_2$$

Calculate the maximum mass of calcium hydroxide which could be made from 2.00 g of calcium oxide.

Relative atomic masses (A_r): H = 1; O = 16; Ca = 40.

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Maximum mass of calcium hydroxide = ... g

(3 marks)

5

4.1.1.6 Relative atomic mass

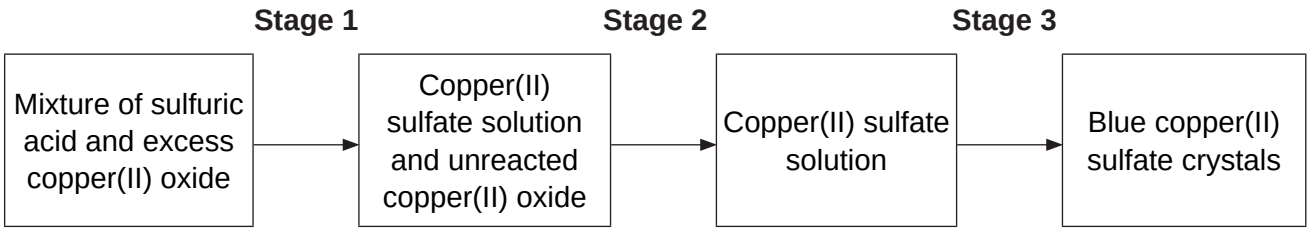
Question 15

January 2013 | CH2HP | Original Q3 | Legacy

3 This question is about compounds of copper.

3 (a) A student made some copper(II) sulfate crystals.

The flow diagram shows the stages of the preparation of copper(II) sulfate crystals.



3 (a) (i) The reaction mixture is heated in **Stage 1**.

Suggest why.

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(1 mark)

3 (a) (ii) Complete the equation for this reaction.

CuO + ... → $CuSO_4$ + ...

(2 marks)

3 (a) (iii) How would the student remove the unreacted copper(II) oxide in **Stage 2**?

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(1 mark)

3 (a) (iv) How would the student obtain copper(II) sulfate crystals from the copper(II) sulfate solution in **Stage 3**?

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(1 mark)

3 (a) (v) The mass of crystals obtained was less than the student had calculated.

Suggest **one** reason why.

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(1 mark)

4.1.1.6 Relative atomic mass

Question 15 · continued

3 (b) The student heated the blue copper(II) sulfate crystals.

The word equation for the reaction is shown below.

hydrated copper(II) sulfate ⇌ anhydrous copper(II) sulfate + water

blue white

3 (b) (i) What does the symbol ⇌ mean ?

.....

(1 mark)

3 (b) (ii) 300 J of energy are taken in when some blue copper(II) sulfate crystals are heated.

What is the energy change when an excess of water is added to the anhydrous copper(II) sulfate produced?

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(2 marks)

3 (c) A sample of copper nitride contains 3.81 g of copper and 0.28 g of nitrogen.

Calculate the empirical formula.

You **must** show all your working to get full marks.

Relative atomic masses (A_r): N = 14; Cu = 63.5.

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Empirical formula = ...

(4 marks)

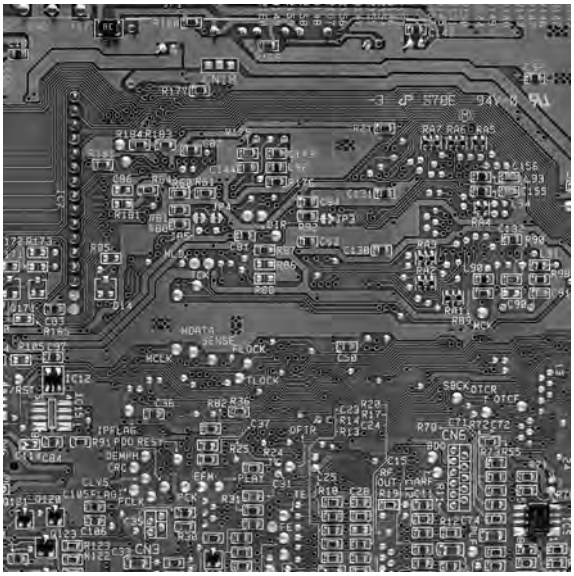
13

4.1.1.6 Relative atomic mass

Question 16

January 2013 | CH2HP | Original Q7 | Legacy

7 Etching is a way of making printed circuit boards for computers.



Printed circuit boards are made when copper sheets are etched using iron(III) chloride solution. Where the copper has been etched, only plastic remains.

7 (a) Copper is a good conductor of electricity.

Explain why.

.....

.....

.....

.....

(2 marks)

4.1.1.6 Relative atomic mass

Question 16 · continued

7 (b) Iron(III) chloride can be produced by the reaction shown in the equation:

$$2\,Fe + 3\,Cl_2 \rightarrow 2\,FeCl_3$$

7 (b) (i) Calculate the maximum mass of iron(III) chloride ($FeCl_3$) that can be produced from 11.20 g of iron.

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

.....

.....

.....

.....

.....

Maximum mass of iron(III) chloride = ... g

(3 marks)

7 (b) (ii) The actual mass of iron(III) chloride ($FeCl_3$) produced was 24.3 g.

Calculate the percentage yield.

(If you did not answer part (b)(i) assume that the maximum theoretical mass of iron(III) chloride ($FeCl_3$) is 28.0 g. This is **not** the correct answer to part (b)(i).)

.....

.....

Percentage yield = ...%

(1 mark)

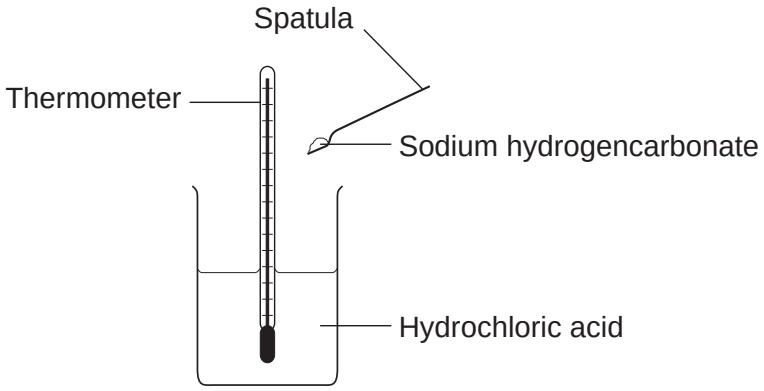
6

4.1.1.6 Relative atomic mass

Question 17

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

4.1.1.6 Relative atomic mass

Question 17 · 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

4.1.1.6 Relative atomic mass

Question 17 · 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)

4.1.1.6 Relative atomic mass

Question 17 · 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

4.1.1.6 Relative atomic mass

Question 18

June 2013 | CH2HP | Original Q3 | Legacy

3 Ammonia is produced from nitrogen and hydrogen.

The equation for this reaction is:

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

3 (a) (i) A company wants to make 6.8 tonnes of ammonia.

Calculate the mass of nitrogen needed.

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

.....

.....

.....

.....

.....

Mass of nitrogen = ... tonnes

(3 marks)

3 (a) (ii) The company expected to make 6.8 tonnes of ammonia.

The yield of ammonia was only 4.2 tonnes.

Calculate the percentage yield of ammonia.

.....

.....

Percentage yield of ammonia = ... %

(2 marks)

3 (a) (iii) Use the equation above to explain why the percentage yield of ammonia was less than expected.

.....

.....

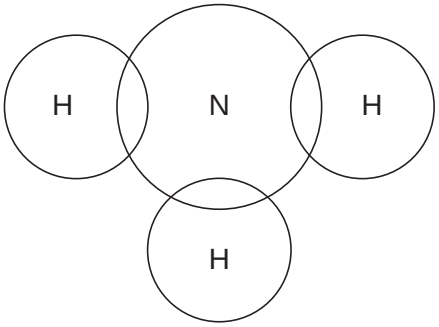
(1 mark)

4.1.1.6 Relative atomic mass

Question 18 · continued

3 (b) Complete the diagram to show the arrangement of the outer shell electrons of the nitrogen and hydrogen atoms in ammonia.

Use dots (●) and crosses (x) to represent the electrons.



(2 marks)

3 (c) Ammonia dissolves in water to produce an alkaline solution.

3 (c) (i) Which ion makes ammonia solution alkaline?

.....

(1 mark)

3 (c) (ii) Name the type of reaction between aqueous ammonia solution and an acid.

.....

(1 mark)

3 (c) (iii) Name the acid needed to produce ammonium nitrate.

.....

(1 mark)

3 (c) (iv) The reaction of ammonia with sulfuric acid produces ammonium sulfate.

Use the formulae of the ions on the Chemistry Data Sheet.

Write the formula of ammonium sulfate.

.....

(1 mark)

12

4.1.1.6 Relative atomic mass

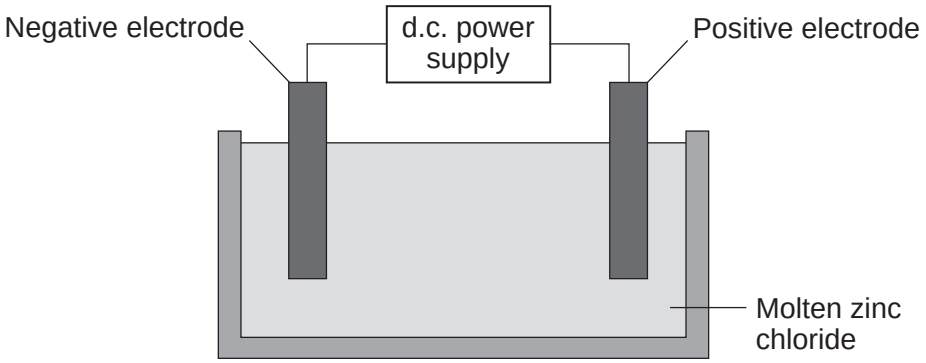
Question 19

June 2014 | CH2HP | Original Q4 | Legacy

4 This question is about zinc and magnesium.

Zinc is produced by electrolysis of molten zinc chloride, as shown in **Figure 4**.

Figure 4



4 (a) (i) Why must the zinc chloride be molten for electrolysis?

[1 mark]

.....

.....

4 (a) (ii) Describe what happens at the negative electrode.

[3 marks]

.....

.....

.....

.....

.....

.....

4 (a) (iii) Complete the half equation for the reaction at the positive electrode.

[1 mark]

..... $\longrightarrow$ Cl_2 + ... e^-

4.1.1.6 Relative atomic mass

Question 19 · continued

4 (b) Magnesium can be produced from magnesium oxide.

The equation for the reaction is:

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

4 (b) (i) How can you tell from the equation that the reaction is done at a high temperature?

[1 mark]

.....

.....

4 (b) (ii) This reaction to produce magnesium from magnesium oxide is **endothermic**.

What is meant by an **endothermic** reaction?

[1 mark]

.....

.....

4 (b) (iii) A company made magnesium using this reaction.

Calculate the mass of magnesium oxide needed to produce 1.2 tonnes of magnesium.

Relative atomic masses (A_r): O = 16; Mg = 24

[3 marks]

.....

.....

.....

.....

Mass of magnesium oxide needed = ... tonnes

4.1.1.6 Relative atomic mass

Question 19 · continued

4 (b) (iv) The company calculated that they would produce 1.2 tonnes of magnesium, but only 0.9 tonnes was produced.

Calculate the percentage yield.

[1 mark]

.....

.....

Percentage yield = ... %

4 (b) (v) Give **one** reason why the calculated yield of magnesium might not be obtained.

[1 mark]

.....

.....

12

Turn over for the next question

4.1.1.6 Relative atomic mass

Question 20

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

4.1.1.6 Relative atomic mass

Question 21

June 2015 | CH2HP | Original Q5 | Legacy

5 This question is about compounds.

5 (a) **Table 2** gives information about the solubility of some compounds.

Table 2

Soluble compounds
All potassium and sodium salts
All nitrates
Chlorides, bromides and iodides, except those of silver and lead

Use information from **Table 2** to answer these questions.

5 (a) (i) Name a soluble compound that contains silver ions.

[1 mark]

.....

5 (a) (ii) Name a soluble compound that contains carbonate ions.

[1 mark]

.....

5 (b) Metal oxides react with acids to make salts.

What type of compound is a metal oxide?

[1 mark]

.....

4.1.1.6 Relative atomic mass

Question 21 · continued

5 (c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

5 (c) (i) State how solid lead nitrate can be obtained from lead nitrate solution.

[1 mark]

.....

.....

5 (c) (ii) Balance the equation for the reaction.

[1 mark]

$$PbO + HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$$

5 (c) (iii) Give the total number of atoms in the formula $Pb(NO_3)_2$

[1 mark]

.....

5 (d) An oxide of lead that does **not** have the formula PbO contains 6.21 g of lead and 0.72 g of oxygen.

Calculate the empirical formula of this lead oxide.

Relative atomic masses (A_r): O = 16; Pb = 207

You must show your working to gain full marks.

[4 marks]

.....

.....

.....

.....

.....

.....

Empirical formula = ...

10

4.1.1.6 Relative atomic mass

Question 22

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 = _____ %

4.1.1.6 Relative atomic mass

Question 22 · 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 22 · 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.

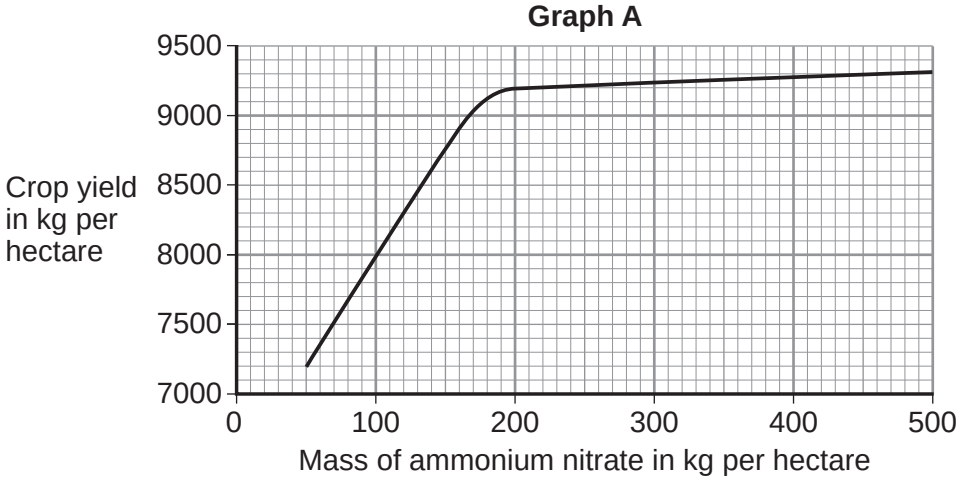
Rainwater dissolves ammonium nitrate in the soil.

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

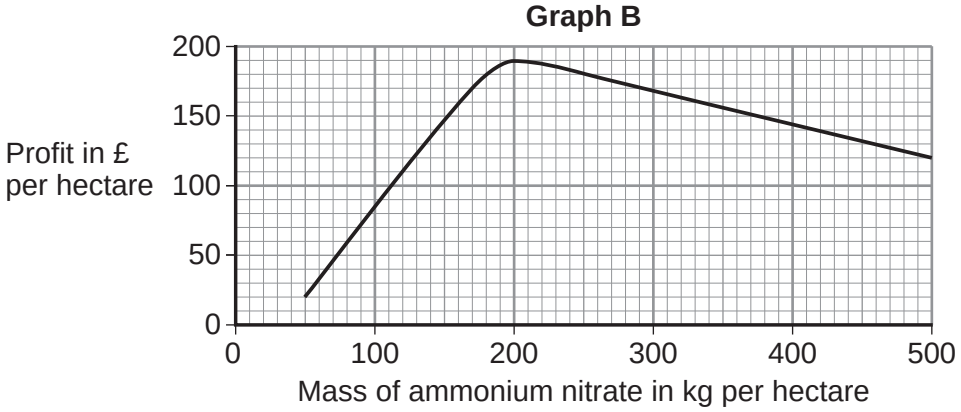
Figure 2 shows three graphs **A**, **B** and **C**. The graphs show information about the use of ammonium nitrate as a fertiliser. A hectare is a measurement of an area of land.

Figure 2

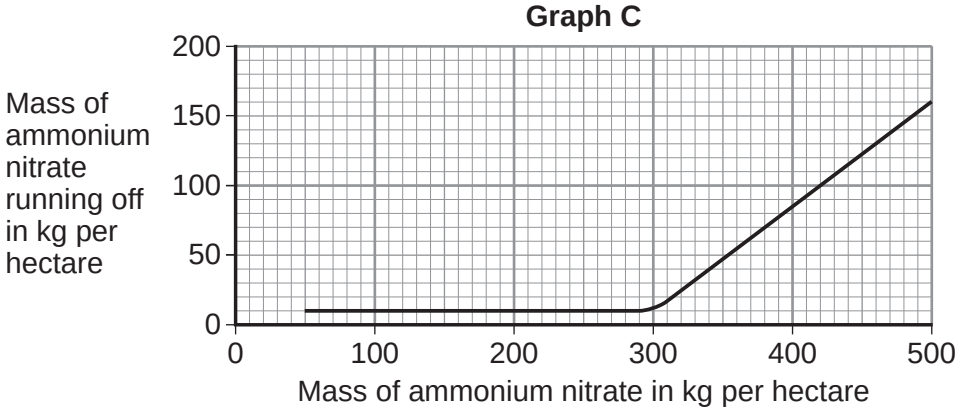
Graph A



Graph B



Graph C



4.1.1.6 Relative atomic mass

Question 22 · 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

4.1.1.6 Relative atomic mass

Question 23

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

4.1.1.6 Relative atomic mass

Question 23 · 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

4.1.1.6 Relative atomic mass

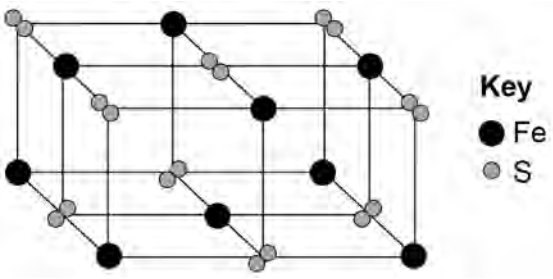
Question 24

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 _____

_____

4.1.1.6 Relative atomic mass

Question 24 · 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

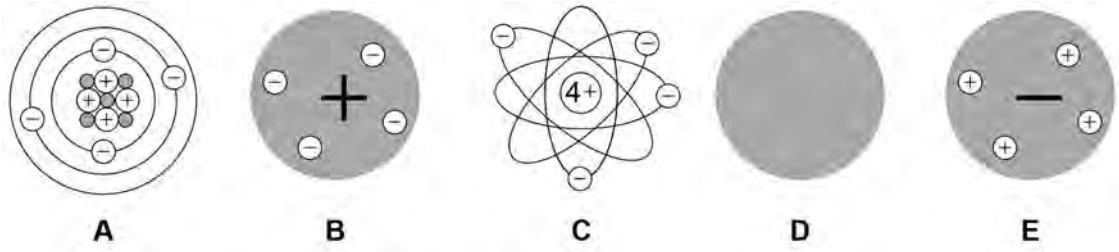
4.1.1.6 Relative atomic mass

Question 25

June 2018 | 8462/1H | Original Q4

0 4 **Figure 3** represents different models of the atom.

Figure 3



0 4 . 1 Which diagram shows the plum pudding model of the atom?

[1 mark]

Tick **one** box.

A		B		C		D		E	

0 4 . 2 Which diagram shows the model of the atom developed from the alpha particle scattering experiment?

[1 mark]

Tick **one** box.

A		B		C		D		E	

0 4 . 3 Which diagram shows the model of the atom resulting from Bohr's work?

[1 mark]

Tick **one** box.

A		B		C		D		E	

4.1.1.6 Relative atomic mass

Question 25 · continued

0 4 . 4 Define the mass number of an atom.

[1 mark]

0 4 . 5 Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of ^{69}**X**
- 40% of ^{71}**X**

Estimate the relative atomic mass of element **X**.

[1 mark]

Tick **one** box.

< 69.5 ☐

Between 69.5 and 70.0 ☐

Between 70.0 and 70.5 ☐

> 70.5 ☐

0 4 . 6 Chadwick's experimental work on the atom led to a better understanding of isotopes.

Explain how his work led to this understanding.

[3 marks]

8

4.1.1.6 Relative atomic mass

Question 26

June 2018 | 8462/1H | Original Q8

0 8 Titanium is a transition metal.

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

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

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

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

[1 mark]

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

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

[1 mark]

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

[2 marks]

4.1.1.6 Relative atomic mass

Question 26 · continued

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

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

[3 marks]

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

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

Why is this an oxidation reaction?

[1 mark]

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

[1 mark]

Na → _____ + _____

4.1.1.6 Relative atomic mass

Question 26 · continued

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

The equation for the reaction is:

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

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

Explain why titanium chloride is the limiting reactant.

You **must** show your working.

[4 marks]

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

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

Calculate the actual mass of titanium produced.

[2 marks]

Mass of titanium = _____ kg

15

4.1.1.6 Relative atomic mass

Question 27

June 2019 | 8462/1H | Original Q4

0 4 This question is about atomic structure.

0 4 . 1 Atoms contain subatomic particles.

Table 2 shows properties of two subatomic particles.

Complete **Table 2**.

[2 marks]

Table 2

Name of particle	Relative mass	Relative charge
neutron		
		+1

An element **X** has two isotopes.

The isotopes have different mass numbers.

0 4 . 2 Define mass number.

[1 mark]

0 4 . 3 Why is the mass number different in the two isotopes?

[1 mark]

Question 4 continues on the next page

4.1.1.6 Relative atomic mass

Question 27 · continued

0 4 . 4 The model of the atom changed as new evidence was discovered.

The plum pudding model suggested that the atom was a ball of positive charge with electrons embedded in it.

Evidence from the alpha particle scattering experiment led to a change in the model of the atom from the plum pudding model.

Explain how.

[4 marks]

8

4.1.1.6 Relative atomic mass

Question 28

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]

$\rightarrow \quad O_2 \quad +$

4.1.1.6 Relative atomic mass

Question 28 · 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

4.1.1.6 Relative atomic mass

Question 28 · 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

4.1.1.6 Relative atomic mass

Question 29

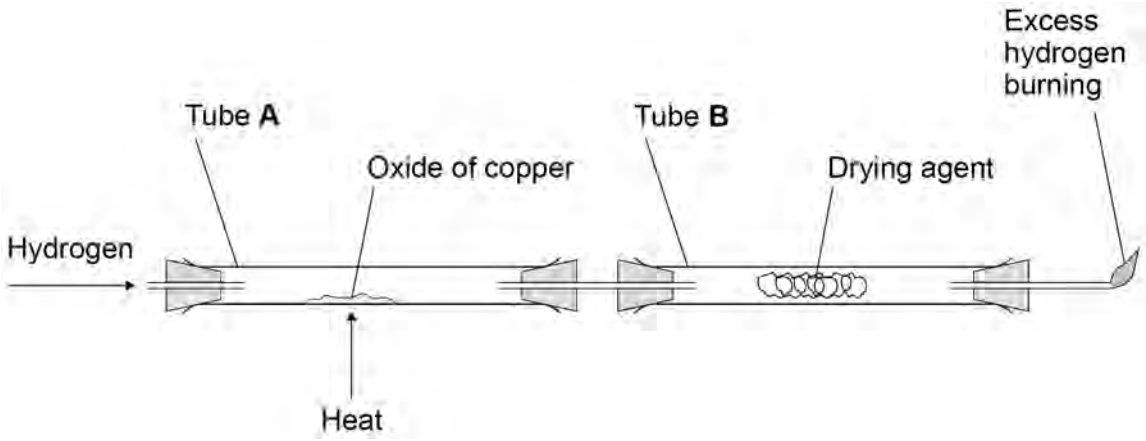
June 2019 | 8462/1H | Original Q8

0 8 Copper forms two oxides, Cu_2O and CuO

A teacher investigated an oxide of copper.

Figure 10 shows the apparatus.

Figure 10



This is the method used.

1. Weigh empty tube **A**.
2. Add some of the oxide of copper to tube **A**.
3. Weigh tube **A** and the oxide of copper.
4. Weigh tube **B** and drying agent.
5. Pass hydrogen through the apparatus and light the flame at the end.
6. Heat tube **A** for 2 minutes.
7. Reweigh tube **A** and contents.
8. Repeat steps 5 to 7 until the mass no longer changes.
9. Reweigh tube **B** and contents.
10. Repeat steps 1 to 9 with different masses of the oxide of copper.

4.1.1.6 Relative atomic mass

Question 29 · continued

0 8 . 1 Suggest **one** reason why step 8 is needed.

[1 mark]

0 8 . 2 Explain why the excess hydrogen must be burned off.

[2 marks]

Question 8 continues on the next page

Question 29 · continued

Figure 10 is repeated here.

Figure 10

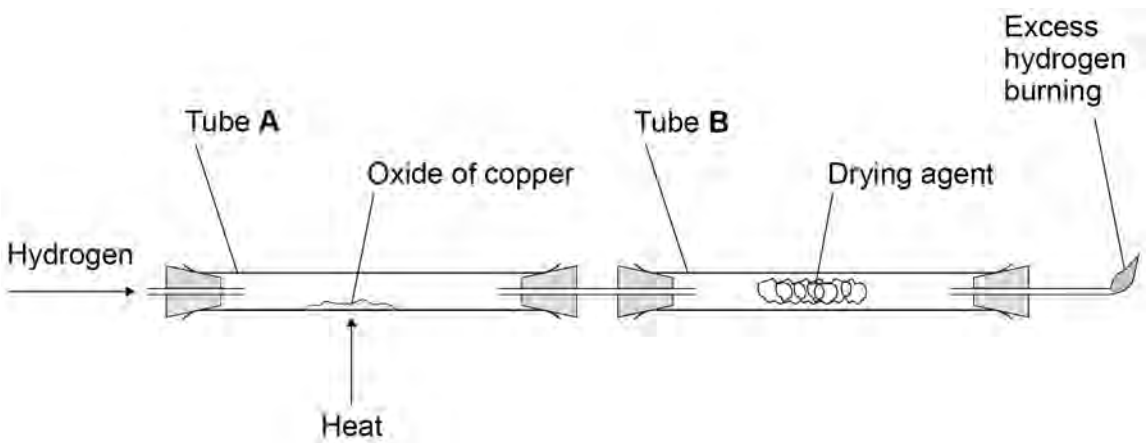


Table 5 shows the teacher's results.

Table 5

	Mass in g
Tube **A** empty	105.72
Tube **A** and oxide of copper before heating	115.47
Tube **A** and contents after 2 minutes	114.62
Tube **A** and contents after 4 minutes	114.38
Tube **A** and contents after 6 minutes	114.38
Tube **B** and contents at start	120.93
Tube **B** and contents at end	123.38

When an oxide of copper is heated in a stream of hydrogen, the word equation for the reaction is:

copper oxide + hydrogen → copper + water

4.1.1.6 Relative atomic mass

Question 29 · continued

0 8 . 3 Determine the mass of copper and the mass of water produced in this experiment.

Use **Table 5**.

[2 marks]

Mass of copper = _____ g

Mass of water = _____ g

0 8 . 4 The teacher repeated the experiment with a different sample of the oxide of copper.

The teacher found that the oxide of copper produced 2.54 g of copper and 0.72 g of water.

Two possible equations for the reaction are:

Equation 1: $Cu_2O + H_2 \rightarrow 2Cu + H_2O$

Equation 2: $CuO + H_2 \rightarrow Cu + H_2O$

Determine which is the correct equation for the reaction in the teacher's experiment.

Relative atomic masses (A_r): H = 1 O = 16 Cu = 63.5

[3 marks]

8

4.1.1.6 Relative atomic mass

Question 30

June 2019 | 8462/1H | Original Q9

0 9 A student investigated the temperature change in the reaction between dilute sulfuric acid and potassium hydroxide solution.

This is the method used.

1. Measure 25.0 cm^3 potassium hydroxide solution into a polystyrene cup.

2. Record the temperature of the solution.

3. Add 2.0 cm^3 dilute sulfuric acid.

4. Stir the solution.

5. Record the temperature of the solution.

6. Repeat steps 3 to 5 until a total of 20.0 cm^3 dilute sulfuric acid has been added.

0 9 . 1 Suggest why the student used a polystyrene cup rather than a glass beaker for the reaction.

[2 marks]

Question 9 continues on the next page

4.1.1.6 Relative atomic mass

Question 30 · continued

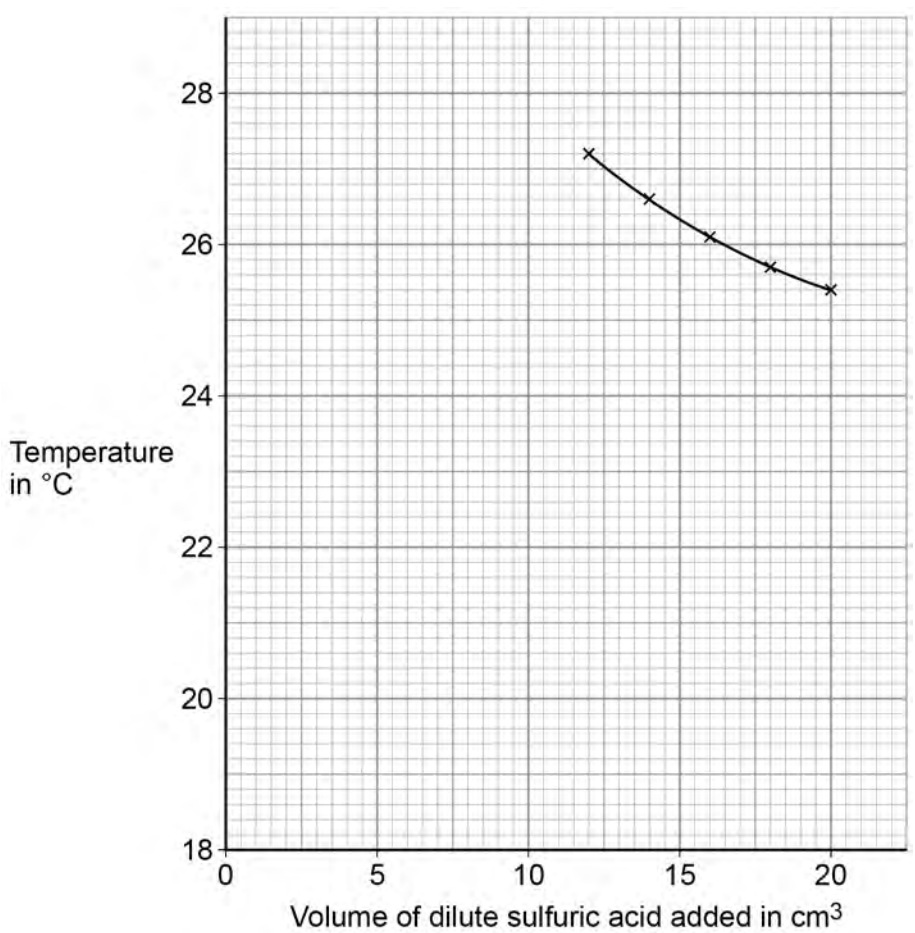
Table 6 shows some of the student's results.

Table 6

Volume of dilute sulfuric acid added in cm^3	Temperature in °C
0.0	18.9
2.0	21.7
4.0	23.6
6.0	25.0
8.0	26.1
10.0	27.1

Figure 11 shows some of the data from the investigation.

Figure 11



4.1.1.6 Relative atomic mass

Question 30 · continued

0 9 . 2 Complete **Figure 11**:

- plot the data from **Table 6**
- draw a line of best fit through these points
- extend the lines of best fit until they cross.

[4 marks]

0 9 . 3 Determine the volume of dilute sulfuric acid needed to react completely with 25.0 cm^3 of the potassium hydroxide solution.

Use **Figure 11**.

[1 mark]

Volume of dilute sulfuric acid to react completely = _____ cm^3

0 9 . 4 Determine the overall temperature change when the reaction is complete.

Use **Figure 11**.

[1 mark]

_____

_____

Overall temperature change = _____ °C

Question 9 continues on the next page

4.1.1.6 Relative atomic mass

Question 30 · continued

0 9 . 5 The student repeated the investigation.

The student used solutions that had different concentrations from the first investigation.

The student found that 15.5 cm^3 of 0.500 mol/dm^3 dilute sulfuric acid completely reacted with 25.0 cm^3 of potassium hydroxide solution.

The equation for the reaction is:

$$2\,KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\,H_2O$$

Calculate the concentration of the potassium hydroxide solution in mol/dm^3 and in g/dm^3

Relative atomic masses (A_r): H = 1 O = 16 K = 39

[6 marks]

Concentration in mol/dm^3 = _____ mol/dm^3

Concentration in g/dm^3 = _____ g/dm^3

14

4.1.1.6 Relative atomic mass

Question 31

June 2019 | 8462/2H | Original Q10

1 0 This question is about reversible reactions and equilibrium.

Hydrogen is used to produce ammonia in the Haber process.

The hydrogen is made in two stages.

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

The equation for the reaction is:

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

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

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

[2 marks]

Atom economy = _____ %

4.1.1.6 Relative atomic mass

Question 31 · continued

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

Give your answer in terms of equilibrium.

[2 marks]

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

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

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

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

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

[1 mark]

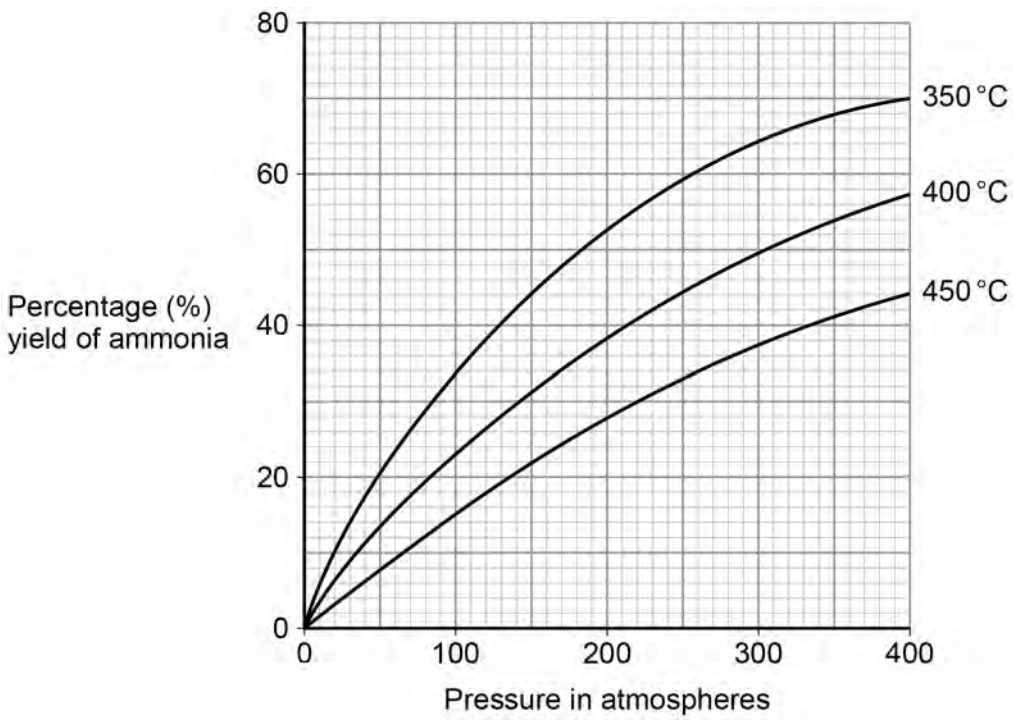
Question 10 continues on the next page

4.1.1.6 Relative atomic mass

Question 31 · continued

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

Figure 10



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

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

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

Use **Figure 10**.

[3 marks]

Percentage yield = _____ times greater

4.1.1.6 Relative atomic mass

Question 31 · continued

1 0 . 5 A pressure of 285 atmospheres is **not** used in the Haber process instead of 200 atmospheres.

Give **one** reason why.

[1 mark]

1 0 . 6 How does **Figure 10** show that the forward reaction in the Haber process is exothermic?

[1 mark]

1 0 . 7 World production of ammonia is now about 30 times greater than it was in 1950.

Suggest why the demand for ammonia has increased.

[2 marks]

12

4.1.1.6 Relative atomic mass

Question 32

November 2020 | 8462/1H | Original Q2

0 2 This question is about metals and the reactivity series.

0 2 . 1 Which **two** statements are properties of most transition metals?

[2 marks]

Tick (✓) **two** boxes.

- They are soft metals. ☐
- They form colourless compounds. ☐
- They form ions with different charges. ☐
- They have high melting points. ☐
- They have low densities. ☐

0 2 . 2 A student added copper metal to colourless silver nitrate solution.

The student observed:

- pale grey crystals forming
- the solution turning blue.

Explain how these observations show that silver is less reactive than copper.

[3 marks]

4.1.1.6 Relative atomic mass

Question 32 · continued

0 2 . 3 A student is given three metals, **X**, **Y** and **Z** to identify.

The metals are magnesium, iron and copper.

Plan an investigation to identify the three metals by comparing their reactions with dilute hydrochloric acid.

Your plan should give valid results.

[4 marks]

Question 2 continues on the next page

4.1.1.6 Relative atomic mass

Question 32 · continued

0 2 . 4 Metal **M** has two isotopes.

Table 2 shows the mass numbers and percentage abundances of the isotopes.

Table 2

Mass number	Percentage abundance (%)
203	30
205	70

Calculate the relative atomic mass (A_r) of metal **M**.

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass (1 decimal place) = _____

11

4.1.1.6 Relative atomic mass

Question 33

November 2020 | 8462/1H | Original Q6

0 6 This question is about displacement reactions.

0 6 . 1 The displacement reaction between aluminium and iron oxide has a high activation energy.

What is meant by 'activation energy'?

[1 mark]

0 6 . 2 A mixture contains 1.00 kg of aluminium and 3.00 kg of iron oxide.

The equation for the reaction is:

$$2\,Al + Fe_2O_3 \rightarrow 2\,Fe + Al_2O_3$$

Show that aluminium is the limiting reactant.

Relative atomic masses (A_r): O = 16 Al = 27 Fe = 56

[4 marks]

4.1.1.6 Relative atomic mass

Question 33 · continued

Magnesium displaces zinc from zinc sulfate solution.

0 6 . 3 Complete the ionic equation for the reaction.

You should include state symbols.

[2 marks]

$$Mg(s) + Zn^{2+}(aq) \rightarrow _____ + _____$$

0 6 . 4 Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction.

[2 marks]

9

4.1.1.6 Relative atomic mass

Question 34

November 2020 | 8462/1H | Original Q8

0 8 This question is about the halogens.

Table 5 shows the melting points and boiling points of some halogens.

Table 5

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

0 8 . 1 What is the state of bromine at 0 °C **and** at 100 °C?

[1 mark]

Tick (✓) **one** box.

State at 0 °C	State at 100 °C	
Gas	Gas	☐
Gas	Liquid	☐
Liquid	Gas	☐
Liquid	Liquid	☐
Solid	Gas	☐
Solid	Liquid	☐

4.1.1.6 Relative atomic mass

Question 34 · continued

0 8 . 2 Explain the trend in boiling points of the halogens shown in **Table 5**.

[4 marks]

0 8 . 3 Why is it **not** correct to say that the boiling point of a single bromine molecule is 59 °C?

[1 mark]

Question 8 continues on the next page

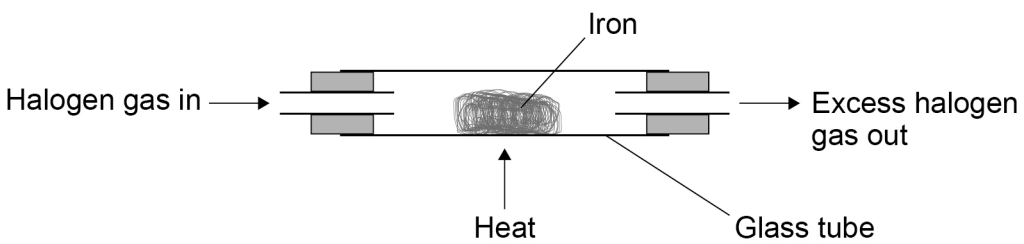
4.1.1.6 Relative atomic mass

Question 34 · continued

Iron reacts with each of the halogens in their gaseous form.

Figure 5 shows the apparatus used.

Figure 5



0 8 . 4 Give **one** reason why this experiment should be done in a fume cupboard.

[1 mark]

0 8 . 5 Explain why the reactivity of the halogens decreases going down the group.

[3 marks]

4.1.1.6 Relative atomic mass

Question 34 · continued

0 8 . 6 A teacher investigated the reaction of iron with chlorine using the apparatus in **Figure 5**.

The word equation for the reaction is:

iron + chlorine → iron chloride

The teacher weighed:

- the glass tube
- the glass tube and iron before the reaction
- the glass tube and iron chloride after the reaction.

Table 6 shows the teacher's results.

Table 6

	Mass in g
Glass tube	51.56
Glass tube and iron	56.04
Glass tube and iron chloride	64.56

Calculate the simplest whole number ratio of:

moles of iron atoms : moles of chlorine atoms

Determine the balanced equation for the reaction.

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

[6 marks]

Moles of iron atoms : moles of chlorine atoms = _____ : _____

Equation for the reaction _____

16

4.1.1.6 Relative atomic mass

Question 35

November 2020 | 8462/1H | Original Q9

0 9 This question is about citric acid ($C_6H_8O_7$).

Citric acid is a solid.

A student investigated the temperature change during the reaction between citric acid and sodium hydrogencarbonate solution.

This is the method used.

1. Pour 25 cm^3 of sodium hydrogencarbonate solution into a polystyrene cup.

2. Measure the temperature of the sodium hydrogencarbonate solution.

3. Add 0.20 g of citric acid to the polystyrene cup.

4. Stir the solution.

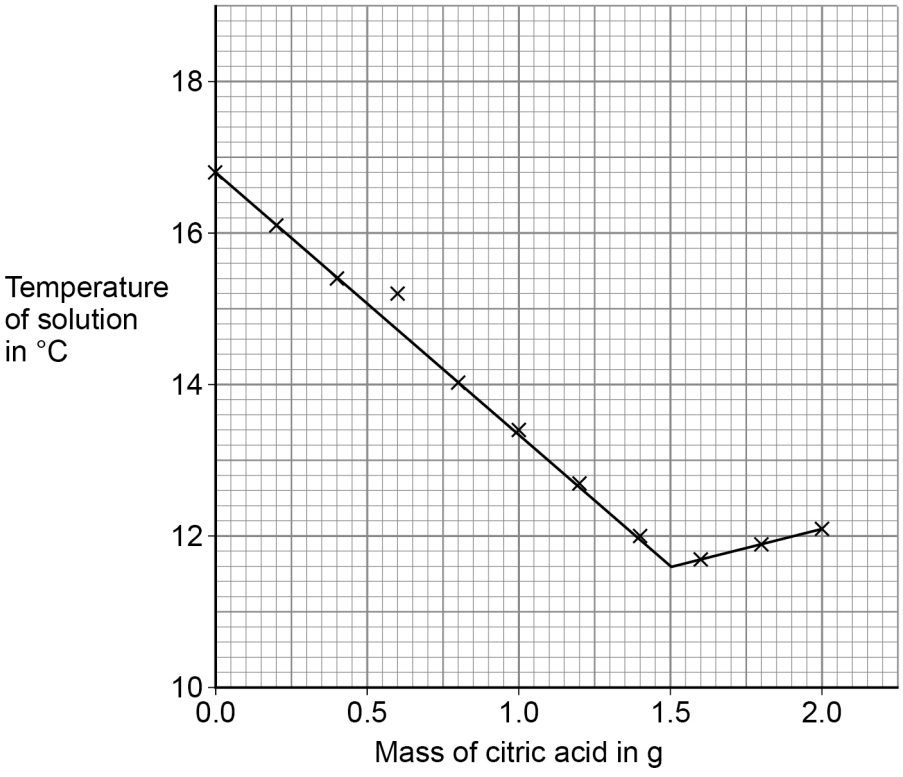
5. Measure the temperature of the solution.

6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added.

The student plotted the results on a graph.

Figure 6 shows the student's graph.

Figure 6



4.1.1.6 Relative atomic mass

Question 35 · continued

0 9 . 1 **Figure 6** shows an anomalous point when 0.60 g of citric acid was added. This was caused by the student making an error.

The student correctly:

- measured the mass of the citric acid
- read the thermometer
- plotted the point.

Suggest **one** reason for the anomalous point.

[1 mark]

0 9 . 2 Explain the shape of the graph in terms of the energy transfers taking place.

You should use data from **Figure 6** in your answer.

[3 marks]

0 9 . 3 A second student repeated the investigation using a metal container instead of the polystyrene cup. The container and the cup were the same size and shape.

Sketch a line on **Figure 6** to show the second student's results until 1.00 g of citric acid had been added. The starting temperature of the solution was the same.

Explain your answer.

[3 marks]

Question 35 · continued

The student used a solution of citric acid to determine the concentration of a solution of sodium hydroxide by titration.

0 9 . 4 The student made 250 cm^3 of a solution of citric acid of concentration 0.0500 mol/dm^3

Calculate the mass of citric acid ($C_6H_8O_7$) required.

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

[3 marks]

Mass = _____ g

This is part of the method the student used for the titration.

1. Measure 25.0 cm^3 of the sodium hydroxide solution into a conical flask using a pipette.
2. Add a few drops of indicator to the flask.
3. Fill a burette with citric acid solution.

0 9 . 5 Describe how the student would complete the titration.

[3 marks]

4.1.1.6 Relative atomic mass

Question 35 · continued

0 9 . 6 Give **two** reasons why a burette is used for the citric acid solution.

[2 marks]

1 _____

_____

2 _____

_____

0 9 . 7 13.3 cm^3 of 0.0500 mol/dm^3 citric acid solution was needed to neutralise 25.0 cm^3 of sodium hydroxide solution.

The equation for the reaction is:

$$3\,NaOH + C_6H_8O_7 \rightarrow C_6H_5O_7Na_3 + 3\,H_2O$$

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

[3 marks]

_____

_____

_____

_____

_____

_____

Concentration = _____ mol/dm^3

18

4.1.1.6 Relative atomic mass

Question 36

November 2021 | 8462/1H | Original Q2

0 2 This question is about atomic structure and the periodic table.

Gallium (Ga) is an element that has two isotopes.

0 2 . 1 Give the meaning of 'isotopes'.

You should answer in terms of subatomic particles.

[2 marks]

0 2 . 2 **Table 1** shows the mass numbers and percentage abundances of the isotopes of gallium.

Table 1

Mass number	Percentage abundance (%)
69	60
71	40

Calculate the relative atomic mass (A_r) of gallium.

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass (1 decimal place) = _____

4.1.1.6 Relative atomic mass

Question 36 · continued

Gallium (Ga) is in Group 3 of the modern periodic table.

0 2 . 3 Give the numbers of electrons and neutrons in an atom of the isotope $^{69}_{31}Ga$

[2 marks]

Number of electrons _____

Number of neutrons _____

0 2 . 4 What is the most likely formula of a gallium ion?

[1 mark]

Tick (✓) **one** box.

Ga^{+} ☐

Ga^{-} ☐

Ga^{3+} ☐

Ga^{3-} ☐

0 2 . 5 Gallium was discovered six years after Mendeleev published his periodic table.

Give **two** reasons why the discovery of gallium helped Mendeleev's periodic table to become accepted.

[2 marks]

1 _____

_____

2 _____

_____

9

4.1.1.6 Relative atomic mass

Question 37

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** = _____

4.1.1.6 Relative atomic mass

Question 37 · 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

4.1.1.6 Relative atomic mass

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

4.1.1.6 Relative atomic mass

Question 38

November 2021 | 8462/1H | Original Q5

0 5 This question is about salts.

0 5 . 1 Name the salt produced by the neutralisation of hydrochloric acid with potassium hydroxide.

[1 mark]

_____

0 5 . 2 Write an ionic equation for the neutralisation of hydrochloric acid with potassium hydroxide.

[1 mark]

_____ + _____ → _____

0 5 . 3 Soluble salts can be produced by reacting dilute hydrochloric acid with an insoluble solid.

Copper, copper carbonate and copper oxide are insoluble solids.

Which of these insoluble solids can be used to make a copper salt by reacting the solid with dilute hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

- Copper and copper carbonate only ☐
- Copper and copper oxide only ☐
- Copper carbonate and copper oxide only ☐
- Copper, copper carbonate and copper oxide ☐

4.1.1.6 Relative atomic mass

Question 38 · continued

A student makes crystals of magnesium sulfate.

This is the method used.

1. Add sulfuric acid to a beaker.
2. Warm the sulfuric acid.
3. Add a spatula of magnesium oxide to the beaker.
4. Stir the mixture.
5. Repeat steps 3 and 4 until there is magnesium oxide remaining in the beaker.
6. Filter the mixture.
7. Evaporate the filtrate gently until crystals start to form.
8. Leave the solution to finish crystallising.

0 5 . 4 Give **one** reason for:

- step 2
- step 5
- step 6.

[3 marks]

Step 2 _____

_____

Step 5 _____

_____

Step 6 _____

_____

0 5 . 5 How should the filtrate be evaporated gently in **step 7**?

[1 mark]

_____

_____

4.1.1.6 Relative atomic mass

Question 38 · continued

0 5 . 6 Iron chloride is produced by heating iron in chlorine gas.

The equation for the reaction is:

$$2\,Fe + 3\,Cl_2 \rightarrow 2\,FeCl_3$$

Calculate the volume of chlorine needed to react with 14 g of iron.

You should calculate:

- the number of moles of iron used
- the number of moles of chlorine that react with 14 g of iron
- the volume of chlorine needed.

Relative atomic mass (A_r): Fe = 56

The volume of 1 mole of gas = 24 dm^3

[3 marks]

Volume of chlorine = _____ dm^3

10

4.1.1.6 Relative atomic mass

Question 39

November 2021 | 8462/1H | Original Q7

0 7 This question is about chemical reactions and electricity.

0 7 . 1 Electrolysis and chemical cells both involve chemical reactions and electricity.

Explain the difference between the processes in electrolysis and in a chemical cell.

[2 marks]

0 7 . 2 A teacher demonstrates the electrolysis of molten lead bromide.

Bromine is produced at the positive electrode.

Complete the half equation for the production of bromine.

You should balance the half equation.

[2 marks]

$$Br^- \rightarrow \quad + \quad$$

0 7 . 3 Two aqueous salt solutions are electrolysed using inert electrodes.

Complete **Table 4** to show the product at each electrode.

[3 marks]

Table 4

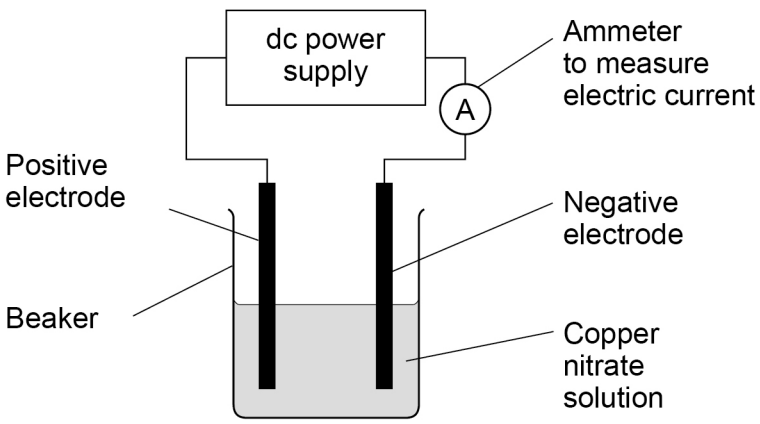
Salt solution	Product at positive electrode	Product at negative electrode
Copper nitrate		copper
Potassium iodide		

Question 39 · continued

Some students investigated the electrolysis of copper nitrate solution using inert electrodes.

Figure 4 shows the apparatus.

Figure 4



The students investigated how the mass of copper produced at the negative electrode varied with:

- time
- current.

This is the method used.

1. Weigh the negative electrode.
2. Set up the apparatus shown in **Figure 4**.
3. Adjust the power supply until the ammeter shows a current of 0.3 A
4. Switch off the power supply after 5 minutes.
5. Rinse the negative electrode with water and allow to dry.
6. Reweigh the negative electrode.
7. Repeat steps 1 to 6 for different times.
8. Repeat steps 1 to 7 at different currents.

4.1.1.6 Relative atomic mass

Question 39 · continued

0 7 . 4 Some of the copper produced did not stick to the negative electrode but fell to the bottom of the beaker.

Suggest how the students could find the total mass of copper produced.

[4 marks]

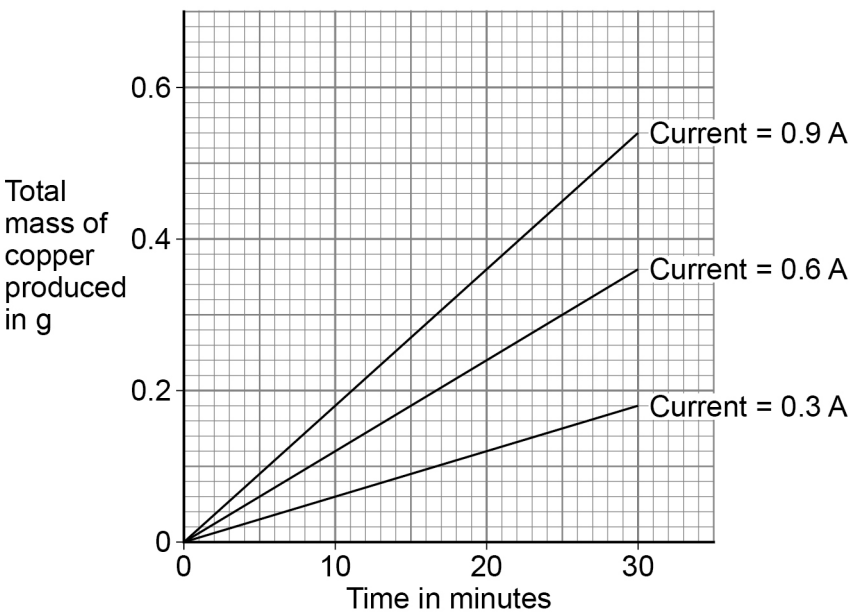
Question 7 continues on the next page

Question 39 · continued

The students plotted their results on a graph.

Figure 5 shows the graph.

Figure 5



A student correctly concluded that the total mass of copper produced is directly proportional both to the time and to the current.

0 7 . 5 How do the results in **Figure 5** support the conclusion that the total mass of copper produced is directly proportional to the time?

[1 mark]

0 7 . 6 How do the results in **Figure 5** support the conclusion that the total mass of copper produced is directly proportional to the current?

Use data from **Figure 5** in your answer.

[1 mark]

4.1.1.6 Relative atomic mass

Question 39 · continued

0 7 . 7 Copper nitrate solution is blue.

Suggest why the blue colour of the copper nitrate solution fades during the electrolysis.

[1 mark]

0 7 . 8 Determine the number of atoms of copper produced when copper nitrate solution is electrolysed for 20 minutes at a current of 0.6 A

Give your answer to 3 significant figures.

Use **Figure 5**.

Relative atomic mass (A_r): Cu = 63.5

The Avogadro constant = 6.02×10^{23} per mole

[3 marks]

Number of atoms (3 significant figures) = _____

17

4.1.1.6 Relative atomic mass

Question 40

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]

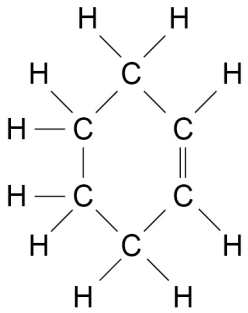
_____

General formula = _____

Question 40 · continued

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

Figure 6

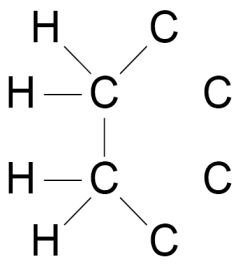


Chlorine reacts with cyclohexene to produce a compound with the formula $C_6H_{10}Cl_2$

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

4.1.1.6 Relative atomic mass

Question 41

June 2022 | 8462/1H | Original Q5

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

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

Rubidium is below potassium in Group 1.

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

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

[1 mark]

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

[3 marks]

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

You should balance the equation.

[3 marks]

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

4.1.1.6 Relative atomic mass

Question 41 · continued

The noble gases are in Group 0.

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

[1 mark]

Tick (✓) **one** box.

- The noble gases all have atoms with eight electrons in the outer shell. ☐
- The noble gases have boiling points that increase going down the group. ☐
- The noble gases have molecules with two atoms. ☐
- The noble gases react with metals to form ionic compounds. ☐

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

Table 1

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

Calculate the relative atomic mass (A_r) of neon.

Give your answer to 3 significant figures.

[3 marks]

Relative atomic mass (3 significant figures) = _____

11

4.1.1.6 Relative atomic mass

Question 42

June 2022 | 8462/1H | Original Q7

0 7 This question is about silicon and compounds of silicon.

0 7 . 1 The reactivity series sometimes includes non-metals such as carbon, hydrogen and silicon.

Silicon can be extracted by reducing silicon dioxide with different substances.

The equation for one possible reaction is:

$$2\,C(s) + SiO_2(s) \rightarrow Si(s) + 2\,CO(g)$$

Explain what this reaction shows about the position of silicon in the reactivity series.

[2 marks]

0 7 . 2 Aluminium also reduces silicon dioxide.

Carbon is used rather than aluminium to reduce silicon dioxide because carbon is cheaper than aluminium.

Carbon can be obtained by heating coal.

Aluminium is obtained from aluminium oxide.

Explain why aluminium is more expensive than carbon.

[2 marks]

4.1.1.6 Relative atomic mass

Question 42 · continued

Magnesium also reduces silicon dioxide.

The equation for the reaction is:

$$2\,Mg(s) + SiO_2(s) \rightarrow Si(s) + 2\,MgO(s)$$

0 7 . 3 Give **one** reason why the products are difficult to separate if magnesium is used to reduce silicon dioxide.

[1 mark]

0 7 . 4 Calculate the minimum mass in grams of magnesium needed to completely reduce 1.2 kg of silicon dioxide.

Relative atomic masses (A_r): O = 16 Mg = 24 Si = 28

[5 marks]

Minimum mass of magnesium = _____ g

4.1.1.6 Relative atomic mass

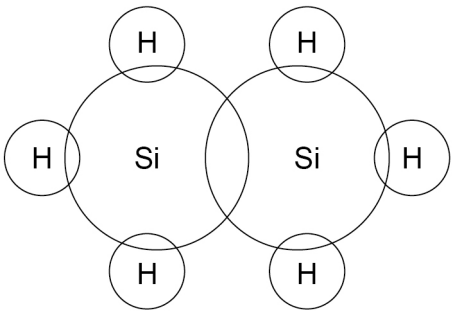
Question 42 · continued

Si_2H_6 is a covalent compound of silicon and hydrogen.

0 7 . 5 Complete **Figure 9** to show the outer shell electrons in a molecule of Si_2H_6

[1 mark]

Figure 9



0 7 . 6 Si_2H_6 reacts with oxygen.

The equation for the reaction is:

$$2\,Si_2H_6(g) + 7\,O_2(g) \rightarrow 4\,SiO_2(s) + 6\,H_2O(g)$$

30 cm^3 of Si_2H_6 is reacted with 150 cm^3 (an excess) of oxygen.

Calculate the total volume of gases present after the reaction.

All volumes of gases are measured at the same temperature and pressure.

[4 marks]

Volume of gases = _____ cm^3

15

4.1.1.6 Relative atomic mass

Question 43

June 2023 | 8462/1H | Original Q1

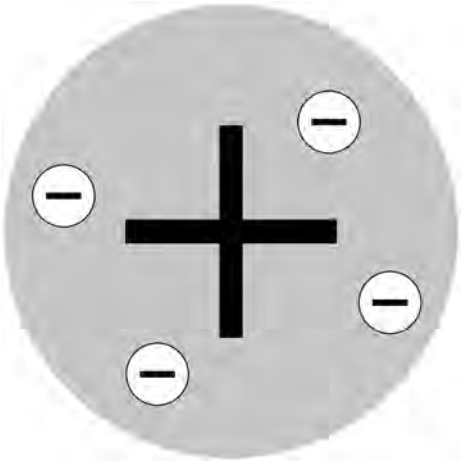
0 1 Discoveries in chemistry led to a better understanding of atomic structure.

0 1 . 1 Atoms were originally thought to be tiny spheres that could not be divided.

The plum pudding model of the atom was then developed.

Figure 1 represents the plum pudding model of the atom.

Figure 1



Describe the plum pudding model of the atom.

[2 marks]

0 1 . 2 Atoms contain electrons, neutrons and protons.

Write these three particles in order of their discovery.

[1 mark]

Earliest _____

_____

Latest _____

4.1.1.6 Relative atomic mass

Question 43 · continued

Very few atoms of the element tennessine (Ts) have ever been identified.

The atomic number of tennessine is 117

0 1 . 3 Predict the number of outer shell electrons in an atom of tennessine.

Give **one** reason for your answer.

Use the periodic table.

[2 marks]

Number of outer shell electrons _____

Reason _____

_____

0 1 . 4 Tennessine was first identified by a small group of scientists in 2010.

Suggest **one** reason why tennessine was **not** accepted as a new element by other scientists until 2015.

[1 mark]

_____

_____

Question 1 continues on the next page

4.1.1.6 Relative atomic mass

Question 43 · continued

0 1 . 5 The discovery of isotopes explained why some relative atomic masses are not whole numbers.

Element **R** has two isotopes.

Table 1 shows the mass numbers and percentage abundances of the isotopes of element **R**.

Table 1

Mass number	Percentage abundance (%)
6	7.6
7	92.4

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

Give your answer to 1 decimal place.

[3 marks]

Relative atomic mass (1 decimal place) = _____

9

4.1.1.6 Relative atomic mass

Question 44

June 2023 | 8462/1H | Original Q9

0 9 This question is about displacement reactions.

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

The equation for the reaction is:

$$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$$

0 9 . 1 Which substance in the equation is reduced?

Give **one** reason for your answer.

Answer in terms of oxygen.

[2 marks]

Substance reduced _____

Reason _____

_____

0 9 . 2 Which expression shows how to calculate the mass of carbon needed to produce 1 mole of iron from iron oxide?

Relative atomic mass (A_r): C = 12

[1 mark]

Tick (✓) **one** box.

$\frac{1}{3} \times 12$ g ☐

$\frac{3}{2} \times 12$ g ☐

1×12 g ☐

3×12 g ☐

Question 9 continues on the next page

Question 44 · continued

A student investigated displacement reactions of four different metals represented by **A**, **B**, **C** and **D**.

A, **B**, **C** and **D** are **not** the actual chemical symbols for the metals.

The student:

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

Table 6 shows information about three of the reaction mixtures.

Table 6

Reaction	Metal	Metal nitrate solution	Equation
1	**A**	**B**NO_3	**A** + 2**B**NO_3 → 2**B** + **A**$(NO_3)_2$
2	**C**	**A**$(NO_3)_2$	2**C** + 3**A**$(NO_3)_2$ → 3**A** + 2**C**$(NO_3)_3$
3	**C**	**D**$(NO_3)_2$	no reaction

0 9 . 3 The ionic equation for **Reaction 1** is:

$$\mathbf{A} + 2\mathbf{B}^{+} \rightarrow 2\mathbf{B} + \mathbf{A}^{2+}$$

Why is this a redox reaction?

[1 mark]

Tick (✓) **one** box.

A gains electrons and $\mathbf{B}^{+}$ loses electrons. ☐

A loses electrons and $\mathbf{B}^{+}$ gains electrons. ☐

Both **A** and $\mathbf{B}^{+}$ gain electrons. ☐

Both **A** and $\mathbf{B}^{+}$ lose electrons. ☐

4.1.1.6 Relative atomic mass

Question 44 · continued

0 9 . 4 Which of the four metals has the greatest tendency to form positive ions?

Use **Table 6**.

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 9 . 5 The nitrate ion has the formula NO_3^-

Which of the four metals could be aluminium?

Explain your answer.

Use **Table 6**.

[3 marks]

Metal _____

Explanation _____

_____

_____

_____

Question 9 continues on the next page

4.1.1.6 Relative atomic mass

Question 44 · continued

0 9 . 6 Metal **X** is extracted from an oxide of metal **X** by reaction with hydrogen.

The equation for the reaction is:

$$\mathbf{X}O_3 + 3H_2 \rightarrow \mathbf{X} + 3H_2O$$

The percentage atom economy for obtaining metal **X** by this method is 77.3%.

Calculate the relative atomic mass (A_r) of metal **X**.

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

[4 marks]

Relative atomic mass (A_r) = _____

12

4.1.1.6 Relative atomic mass

Question 45

June 2023 | 8462/1H | Original Q10

1 0 This question is about titanium dioxide (TiO_2).

1 0 . 1 Self-cleaning windows are coated with a layer of nanoparticles of titanium dioxide.

Titanium dioxide:

- helps sunlight break down dirt particles
- attracts water, so dirt is washed away by rain.

Nanoparticles of titanium dioxide are used instead of fine particles of titanium dioxide for coating self-cleaning windows.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

Question 10 continues on the next page

4.1.1.6 Relative atomic mass

Question 45 · continued

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

The equation for the first stage in the process is:

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

Calculate the volume of chlorine gas needed to react completely with 100 kg of titanium dioxide.

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

The volume of one mole of gas = 24 dm^3

[6 marks]

8

Volume = _____ dm^3

4.1.1.6 Relative atomic mass

Question 46

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 _____

4.1.1.6 Relative atomic mass

Question 46 · 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

4.1.1.6 Relative atomic mass

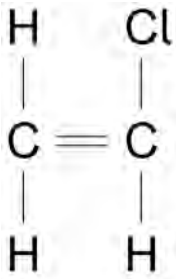
Question 47

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

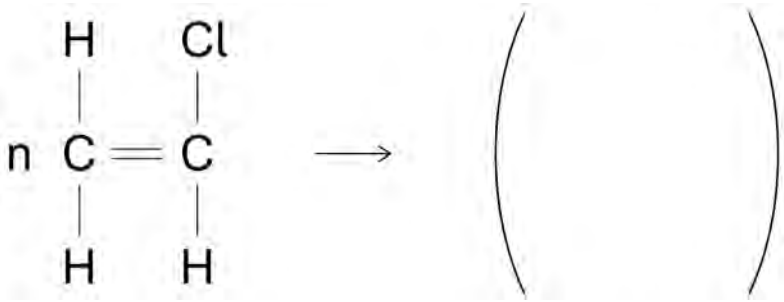


0 8 . 1 Draw a circle around the functional group on the displayed structural formula that allows chloroethene to produce an addition polymer.

[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]

4.1.1.6 Relative atomic mass

Question 47 · 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]

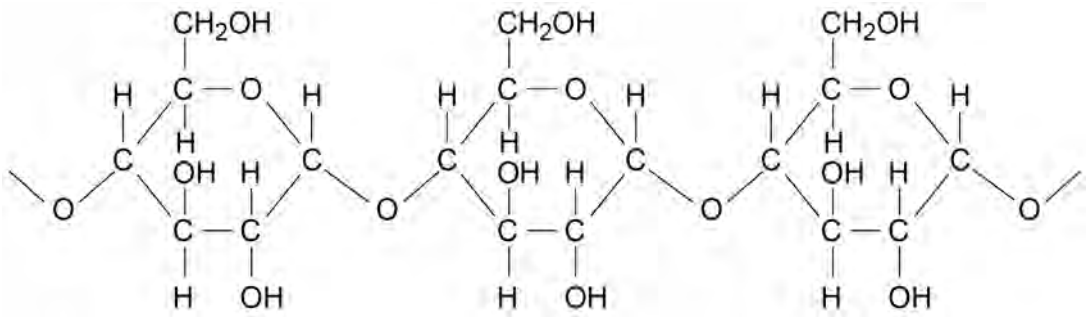
Relative formula mass = _____

4.1.1.6 Relative atomic mass

Question 47 · 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**.

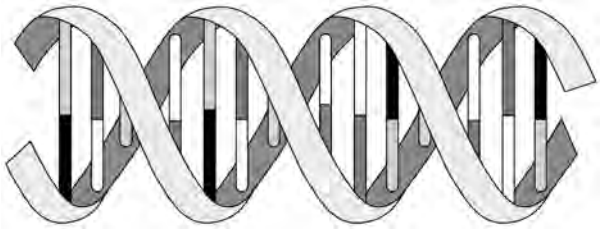
[1 mark]

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

4.1.1.6 Relative atomic mass

Question 48

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

4.1.1.6 Relative atomic mass

Question 48 · 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.

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

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

$3\ Fe^{2+} : 4\ O^{2-}$ ☐

$3\ Fe^{3+} : 4\ O^{2-}$ ☐

4.1.1.6 Relative atomic mass

Question 48 · 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

4.1.1.6 Relative atomic mass

Question 49

June 2025 | 8462/1H | Original Q1

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

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

[1 mark]

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

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

[1 mark]

Tick (✓) **one** box.

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

4.1.1.6 Relative atomic mass

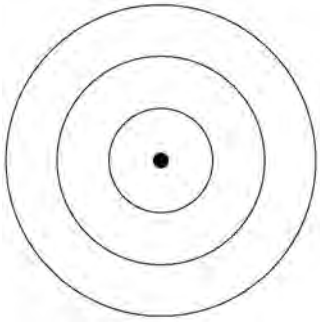
Question 49 · continued

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

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

[1 mark]

Figure 1



0 1 . 4 Mendeleev created an early periodic table.

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

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

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

[1 mark]

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

Explain why argon is unreactive.

[2 marks]

Question 49 · continued

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

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

Answer in terms of subatomic particles.

[2 marks]

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

Table 1

Mass number	Percentage abundance (%)
113	4
115	96

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

[1 mark]

Tick (✓) **one** box.

~113 ☐ ~114 ☐ ~115 ☐

9

4.1.1.6 Relative atomic mass

Question 50

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

4.1.1.6 Relative atomic mass

Question 50 · 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 _____

4.1.1.6 Relative atomic mass

Question 50 · 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

4.1.1.6 Relative atomic mass

Question 51

June 2025 | 8462/2H | Original Q5

0 5 This question is about unsaturated hydrocarbons.

0 5 . 1 **Table 6** shows the boiling points of some unsaturated hydrocarbons.

Table 6

Formula of unsaturated hydrocarbon	Boiling point in °C
C_2H_4	– 104
C_3H_6	– 47
C_4H_8	**X**
C_5H_{10}	30
C_6H_{12}	63

Estimate the boiling point **X** in **Table 6**.

[1 mark]

_____ °C

0 5 . 2 C_2H_4 reacts with water vapour (steam).

Name the compound produced when C_2H_4 reacts with water vapour.

[1 mark]

_____

Question 5 continues on the next page

4.1.1.6 Relative atomic mass

Question 51 · continued

C_4H_8 reacts with chlorine (Cl_2).

0 5 . 3 Describe the test for chlorine.

Give the result of the test.

[2 marks]

Test _____

_____

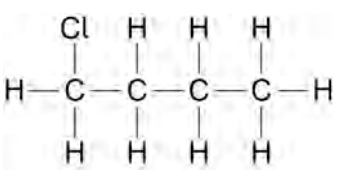
Result _____

_____

0 5 . 4 Which is the displayed formula of the organic compound produced when C_4H_8 reacts with chlorine?

[1 mark]

Tick (✓) **one** box.



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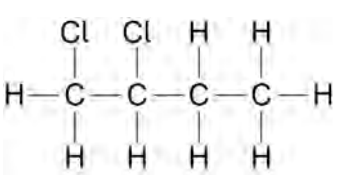

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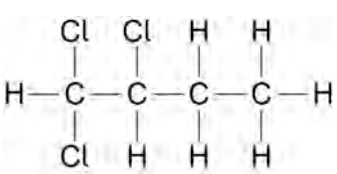

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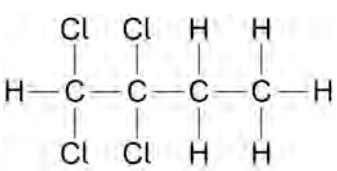

☐

4.1.1.6 Relative atomic mass

Question 51 · continued

0 5 . 5 Name the unsaturated hydrocarbon with the formula C_3H_6

[1 mark]

0 5 . 6 Why does C_3H_6 tend to burn in air with a smoky flame?

[1 mark]

0 5 . 7 C_3H_6 is a gas at room temperature and pressure.

Calculate the volume of 2.1 g of C_3H_6 at room temperature and pressure.

Give your answer in cm^3.

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

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

[5 marks]

Volume = _____ cm^3

12