AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.1.3.2

Typical properties

Past-paper questions

Tier	**Higher**
Question groups	**12**
Available paper years	**2007–2025**

Using this booklet

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

Name: _____ **Date:** _____

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

4.1.3.2 Typical properties

Question 01

June 2007 | CHY1A | Original Q8 | Legacy

QUESTION EIGHT

Exhaust fumes from petrol-driven cars contain harmful gases, particularly acidic nitrogen oxide, poisonous carbon monoxide and unburned hydrocarbons.

Catalytic converters are fitted to these cars to help to reduce the quantities of these gases released into the atmosphere. The reaction in the converter can be summarised by this equation:

carbon monoxide + nitrogen oxide → carbon dioxide + nitrogen

The catalysts in the converters usually contain a mixture of two transition metals, platinum and rhodium.

These metals occur in the Earth's crust mainly with copper and nickel sulfide ores.
To extract the metals, the ores are roasted in air which produces sulfur dioxide.

8A The balanced, symbol equation for the reaction between carbon monoxide and nitrogen oxide is . . .

1 $2CO + 2NO \rightarrow 2CO_2 + N_2$

2 $CO + NO \rightarrow CO_2 + N_2$

3 $2CO + 2NO \rightarrow CO_2 + N_2$

4 $2CO + 2NO \rightarrow CO_2 + 2N_2$

8B Which substance is reduced in this reaction?

1 carbon monoxide

2 carbon dioxide

3 nitrogen oxide

4 nitrogen

8C Why do some environmental organisations question the benefits of catalytic converters?

1 They are expensive to manufacture and make cars more expensive.

2 Polluting gases are released both in producing them and in using them.

3 They do not remove any of the harmful gases from the exhaust fumes.

4 Nitrogen is a poisonous gas.

4.1.3.2 Typical properties

8D What conclusion about the use of catalytic converters can safely be made from the information in this question?

1 Transition metals are good conductors of heat and electricity.

2 There are no harmful gases in the exhaust fumes from a car fitted with a catalytic converter.

3 A catalytic converter reduces the amount of carbon monoxide in the exhaust fumes from a petrol-driven car.

4 Catalytic converters work equally well in both diesel-driven and petrol-driven cars.

Turn over for the next question

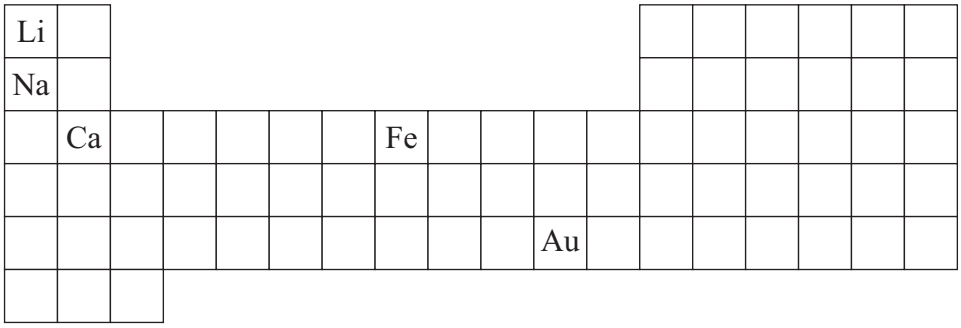
4.1.3.2 Typical properties

Question 02

November 2009 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

The diagram shows part of the periodic table.



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

A Calcium (Ca)

B Lithium (Li)

C Gold (Au)

D Iron (Fe)

1	It will not react with oxygen or water even at high temperatures.
2	It forms the oxide known as quicklime.
3	It has properties most similar to those of sodium (Na).
4	It is a transition element found in the Earth as an oxide.

4.1.3.2 Typical properties

Question 03

March 2019 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The table below gives the temperatures at which some metal carbonates decompose.

Name of metal carbonate	Position of metal in periodic table	Temperature at which it decomposes
Sodium carbonate	Group 1	Decomposes only above its melting point of 851 °C
Calcium carbonate	Third in Group 2	825 °C
Magnesium carbonate	Second in Group 2	350 °C
Zinc carbonate	In the transition metal block	300 °C

8A Which of the following pairs of carbonates would decompose at 750 °C?

1 sodium carbonate and calcium carbonate

2 calcium carbonate and magnesium carbonate

3 sodium carbonate and zinc carbonate

4 magnesium carbonate and zinc carbonate

8B A valid conclusion that can be drawn from the temperatures in the table is that . . .

1 transition metal carbonates are the most thermally stable.

2 Group 2 metal carbonates become less thermally stable down the group.

3 zinc carbonate is the least thermally stable.

4 Group 1 metal carbonates melt before they decompose.

4.1.3.2 Typical properties

Question 03 · continued March 2010 | CHY1AP | Original Q8 | Legacy

8C Extracting metal carbonates, such as limestone, from the ground can cause environmental damage.

A mining company issued this statement:

> Our research shows that our method of mining for limestone causes very little environmental damage.

This statement is . . .

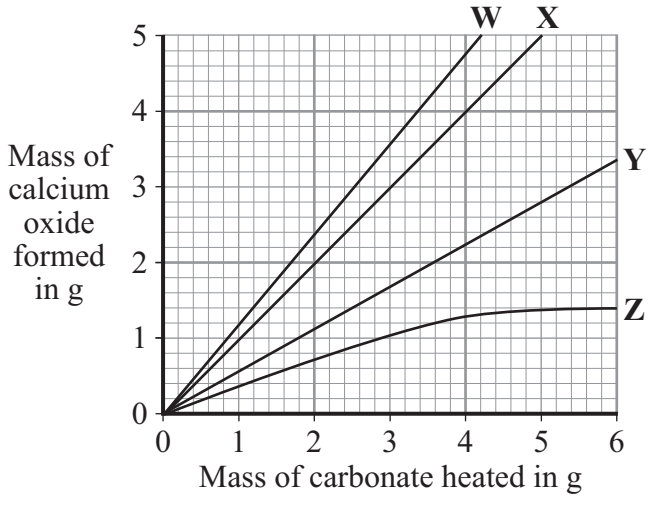
1 given on invalid evidence.

2 an invalid hypothesis.

3 a biased conclusion.

4 based on hearsay.

8D Assuming complete reaction, which of the following lines on the graph represents the mass of calcium oxide formed by heating different masses of calcium carbonate?



1 **W**

2 **X**

3 **Y**

4 **Z**

4.1.3.2 Typical properties

Question 04

June 2010 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about the substances in this reaction:

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

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

A C

B Fe

C CO

D Fe_2O_3

1	In the reaction, it is reduced.
2	It is a transition element.
3	In the reaction, it is oxidised.
4	It is formed by oxidation of a non-metal element.

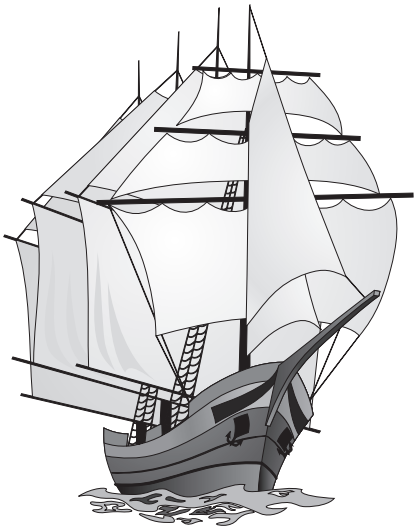
4.1.3.2 Typical properties

Question 05

June 2011 | CHY3H | Original Q2 | Legacy

2 Read the information about protecting the bottoms of ships.

A Copper-bottomed Investment



From the 16th to the 19th century, the bottoms of many wooden ships were protected from marine organisms by being covered with sheets of metal.

At first lead was used on the bottoms of ships, then copper was used until 1832 when Muntz Metal replaced it. Muntz Metal is an alloy of two transition metals, copper and zinc.

Table of data

	Lead	Copper	Muntz Metal
Cost (£/kg)	£1.20	£3.20	£2.30
Melting point (°C)	327	1083	904
Stops sea worms attacking wood	Yes	Yes	Yes
Stops barnacles and seaweed sticking to the bottom of the ship	No	Yes	Yes

4.1.3.2 Typical properties

Question 05 · continued

2 (a) Use the information to answer the following questions.

2 (a) (i) Suggest why copper replaced lead.

.....

.....

(1 mark)

2 (a) (ii) Suggest why Muntz Metal replaced copper.

.....

.....

(1 mark)

2 (b) A sample of Muntz Metal contains a very small amount of iron as an impurity.

2 (b) (i) Name an instrumental method of analysis that could be used to detect iron.

.....

(1 mark)

2 (b) (ii) Suggest why an instrumental method would detect the iron in this sample of Muntz Metal but a chemical method is **not** likely to be successful.

.....

.....

(1 mark)

2 (c) Today, ships are made from steel. Steels are alloys of iron, a transition metal.

Give **two** properties of transition metals that make them suitable for making ships.

Property 1 .....

.....

Property 2 .....

.....

(2 marks)

6

4.1.3.2 Typical properties

Question 06

June 2014 | CH3HP | Original Q3 | Legacy

3 In 1869, Dmitri Mendeleev produced his periodic table of the elements.

Mendeleev placed the alkali metals in the same group.

3 (a) What evidence did Mendeleev use to decide that the alkali metals should be in the same group?

[1 mark]

.....

.....

3 (b) Describe how the elements in the modern periodic table are arranged:

3 (b) (i) in terms of protons

[1 mark]

.....

.....

3 (b) (ii) in terms of electrons.

[1 mark]

.....

.....

3 (c) State **two** properties of transition elements that make them more useful than alkali metals for making water pipes.

[2 marks]

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4.1.3.2 Typical properties

Question 06 · continued

3 (d) Describe and explain the trend in reactivity of the alkali metals (Group 1).

[4 marks]

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9

4.1.3.2 Typical properties

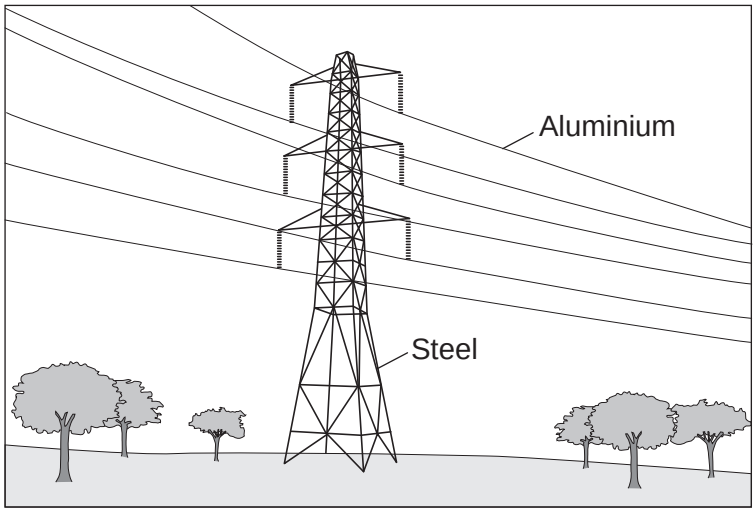
Question 07

June 2015 | CH1HP | Original Q4 | Legacy

4 This question is about metals.

Figure 4 shows the metals used to make pylons and the wires of overhead cables.

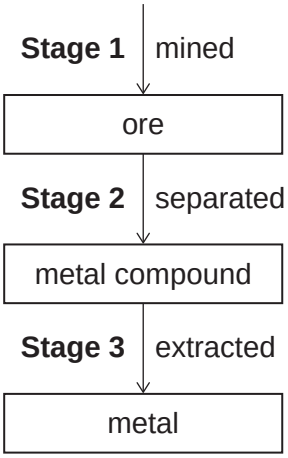
Figure 4



4 (a) An ore contains a metal compound.

A metal is extracted from its ore in three main stages, as shown in **Figure 5**.

Figure 5



Explain why **Stage 2** needs to be done.

[2 marks]

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.....

.....

.....

4.1.3.2 Typical properties

Question 07 · continued

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

4 (b) (i) Cast iron is not suitable for the manufacture of pylons.

Give **one** reason why.

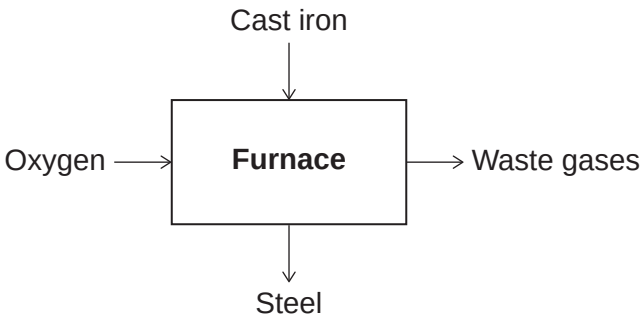
[1 mark]

.....

.....

4 (b) (ii) Most cast iron is converted into steel, as shown in **Figure 6**.

Figure 6



Describe how cast iron is converted into steel.

Use **Figure 6** to help you to answer this question.

[2 marks]

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.....

Question 4 continues on the next page

4.1.3.2 Typical properties

Question 07 · continued

4 (c) Aluminium and copper are good conductors of electricity.

4 (c) (i) State **one** property that makes aluminium more suitable than copper for overhead cables.

[1 mark]

.....

.....

4 (c) (ii) How can you tell that copper is a transition metal and aluminium is **not** a transition metal from the position of each metal in the periodic table?

[2 marks]

.....

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4 (c) (iii) Copper can be extracted from solutions of copper salts by adding iron.

Explain why.

[2 marks]

.....

.....

.....

.....

10

4.1.3.2 Typical properties

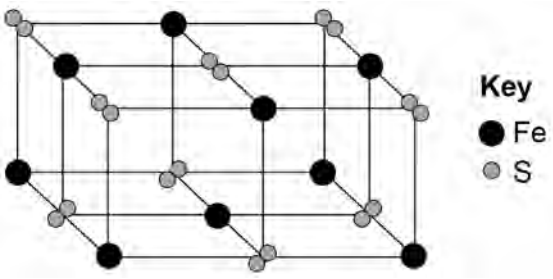
Question 08

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 _____

_____

4.1.3.2 Typical properties

Question 08 · 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

4.1.3.2 Typical properties

Question 09

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]

4.1.3.2 Typical properties

Question 09 · 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 → _____ + _____

4.1.3.2 Typical properties

Question 09 · 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

4.1.3.2 Typical properties

Question 10

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]

4.1.3.2 Typical properties

Question 10 · 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

4.1.3.2 Typical properties

Question 10 · 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

4.1.3.2 Typical properties

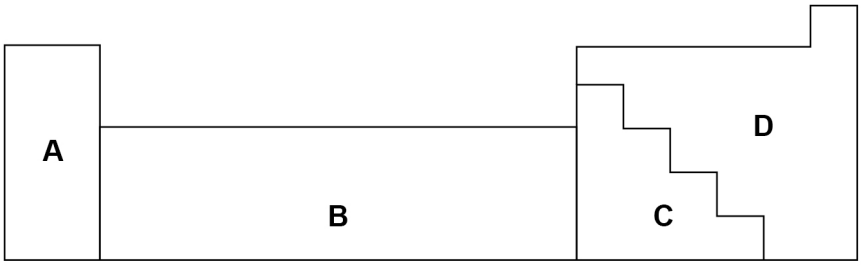
Question 11

June 2022 | 8462/1H | Original Q1

0 1 This question is about metals and non-metals.

Figure 1 shows an outline of part of the periodic table.

Figure 1



0 1 . 1 Element **Q** is a dull solid with a melting point of 44 °C.

Element **Q** does not conduct electricity.

Which section of the periodic table in **Figure 1** is most likely to contain element **Q**?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 1 . 2 Element **R** forms ions of formula R^{2+} and R^{3+}

Which section of the periodic table in **Figure 1** is most likely to contain element **R**?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 1 . 3 Give **two** differences between the physical properties of the elements in Group 1 and those of the transition elements.

[2 marks]

1 _____

_____

2 _____

_____

4.1.3.2 Typical properties

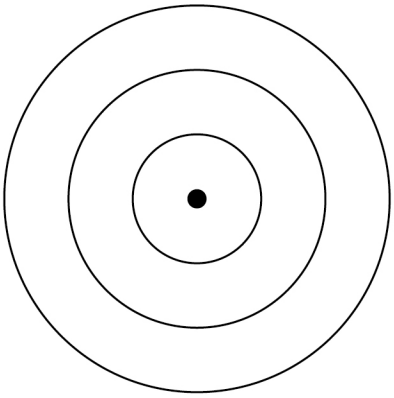
Question 11 · continued

0 1 . 4 Complete **Figure 2** to show the electronic structure of an aluminium atom.

Use the periodic table.

[1 mark]

Figure 2



0 1 . 5 Aluminium is a metal.

Describe how metals conduct electricity.

Answer in terms of electrons.

[3 marks]

0 1 . 6 Name the type of bonding in compounds formed between metals and non-metals.

[1 mark]

4.1.3.2 Typical properties

Question 11 · continued

0 1 . 7 Magnesium oxide is a compound formed from the metal magnesium and the non-metal oxygen.

Describe what happens when a magnesium atom reacts with an oxygen atom.

You should refer to electrons in your answer.

[4 marks]

13

4.1.3.2 Typical properties

Question 12

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

4.1.3.2 Typical properties

Question 12 · 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 _____

4.1.3.2 Typical properties

Question 12 · 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