

GCSE (9-1)

Examiners' report

**GATEWAY SCIENCE
COMBINED
SCIENCE A**

J250

For first teaching in 2016

J250/04 Summer 2023 series

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

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Paper 4 series overview

Candidates were generally quite well prepared for this examination, although the more challenging questions were omitted by many.

Candidates need to show their working in calculations, so that where a final answer is incorrect it may be possible for working and error carried forward marks to be given.

It is important that candidates read the questions carefully, to make sure their answers meet the expectations of the question, e.g. ticking two boxes when asked rather than one, and giving numerical answers to an appropriate number of significant figures (or decimal places).

More successful candidates interpreted data in questions and applied knowledge and understanding to question contexts.

| Candidates who did well on this paper generally: | Candidates who did less well on this paper generally: |
|--|--|
| <ul style="list-style-type: none"> • produced a structured response to the Level of Response question, Question 14, including use of the information in the table alongside their own knowledge • showed working steps in calculations in Questions 12 (c) and 15 (c) (ii) • balanced an equation in Question 15 (a) (i) • predicted products of a reaction in Question 16 (b) • interpreted data in Questions 12 (b) (ii), 13 (a), 13 (b), 16 (c) and 16 (d) • completed bar chart and graph in Questions 13 (a), 16 (c) and 16 (d) • named apparatus and drew a labelled diagram of apparatus in Question 16 (a) • understood the separation of crude oil in Questions 12 (a) (i), 12 (a) (ii), 12 (a) (iii) and 12 (b). | <ul style="list-style-type: none"> • used only the data in the table to ascertain an advantage or disadvantage as their answer to the Level of Response question, Question 14 • struggled to recall knowledge in Questions 11, 12 (a) (i) 12 (a) (ii) 12 (b) (i) 13 (c) (i) and 16 (e) • produced answers to numerical questions without showing working steps in Questions 12 (c) and 15 (c) (ii) • found it difficult to interpret data given in Questions 12 (b) (ii), 13 (a), 13 (b), 16 (c) and 16 (d) • found it difficult to name apparatus and draw apparatus diagrams • showed imprecise use of scientific terminology and processes in Questions 12 (a) (i), 12 (a) (ii) and 12 (b) (i). |

Section A overview

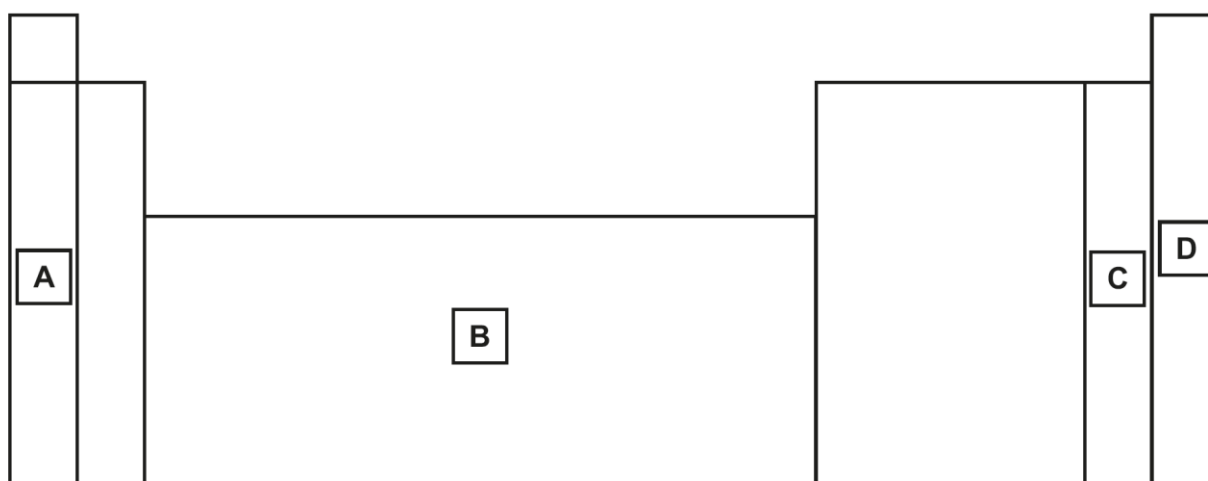
Almost all candidates attempted every question.

Questions on the greenhouse effect (Question 2), reactivity series (Question 3), reading temperature (Question 4) and the Earth's atmosphere (Question 5) were particularly well answered.

Questions on energy profile diagrams (Question 7) and catalysis (Question 9) proved to be more challenging for candidates.

Question 1

1 Which part of the Periodic Table contains the **most reactive** metals?



Your answer

[1]

Many candidates knew that metals are on the left hand side of the Periodic Table, and so B was a popular incorrect response.

Question 2

2 Which process traps heat from the Sun in the Earth's atmosphere?

- A Combustion
- B Displacement
- C Greenhouse effect
- D Photosynthesis

Your answer

[1]

The greenhouse effect was well known, D was also a popular response.

Question 6

6 The table shows the boiling points of three Group 1 elements.

| Element | Boiling point (°C) |
|-----------|--------------------|
| caesium | 669 |
| potassium | 760 |
| rubidium | 686 |

How many of these elements are gases at 700 °C?

- A 0
- B 1
- C 2
- D 3

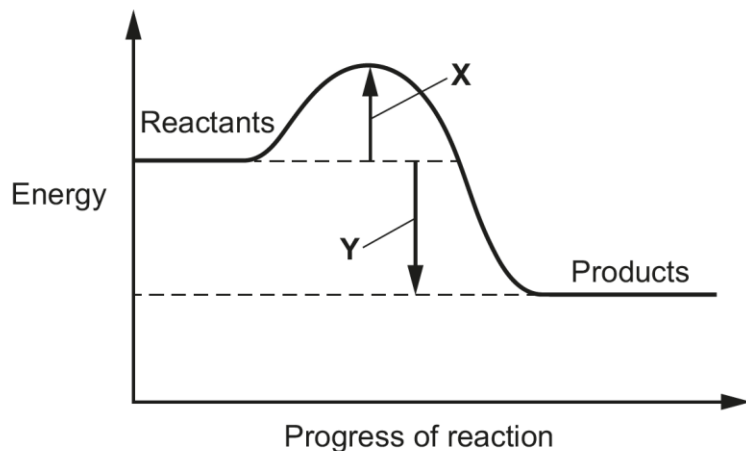
Your answer

[1]

Candidates found this more challenging with many choosing B.

Question 7

7 The diagram shows the reaction profile for an **uncatalysed** reaction.



How does adding a catalyst to the reaction change the reaction profile?

- A X is larger
- B X is smaller
- C Y is larger
- D Y is smaller

Your answer

[1]

The most successful candidates appreciated that a catalyst reduces the activation energy of the reaction and recognised that this energy was represented by X on the diagram. A and C (where the energy was increased) were popular responses.

Question 8

8 Which particles do atoms in Group 7 **gain** when they react?

- A Electrons
- B Ions
- C Neutrons
- D Protons

Your answer

[1]

D was a popular incorrect response.

Question 9

9 Which reactions can be catalysed by an enzyme?

- A Combustion reactions
- B Electrolysis of metal ores
- C Reactions in biological systems
- D Reactions of metals with acids

Your answer

[1]

The more successful candidates appreciated that enzymes catalyse biological systems. D and B were the more popular responses.

Question 10

10 The rate of reaction between magnesium and dilute hydrochloric acid depends on the concentration of the dilute hydrochloric acid.

Which concentration of dilute hydrochloric acid reacts **slowest** with magnesium?

- A 0.089 mol/dm^3
- B 0.500 mol/dm^3
- C 0.038 mol/dm^3
- D 0.630 mol/dm^3

Your answer

[1]

D was a popular incorrect response.

Section B overview

Questions on reversible arrow (Question 11 (a)), bar charts (Question 13 (a)), metal properties (Question 13 (b)) and reactivity of group one (Question 13 (c)) were well answered.

The most challenging questions for candidates were Questions 12 (a) (i) and (ii) on crude oil separation, Question 12 (b) (ii) interpreting a graph, Question 15 (a) (iii) reduction, Question 15 (b) recycling, Question 19 (a) experimental technique, Question 16 (b) predicting product of a reaction, Question 16 (c) interpreting information to ascertain the variable in a graph and Questions 16 (d) and (e) effects of concentration and temperature on the rate of reaction.

A significant number of candidates omitted crude oil separation Questions 12 (a) (i) and 12 (a) (ii), completing a bar chart Question 13 (a), balancing an equation Question 15 (a), reduction Question 15 (a) (iii), recycling Question 15 (b), calculation of reacting mass Question 15 (c) (ii) and rates of reaction Question 16 (all parts).

There was no evidence that candidates did not have enough time to complete the paper.

Question 11 (a)

11 The table shows the equations for four different reactions.

| Reaction | Equation |
|----------|--|
| A | aluminium oxide \rightarrow aluminium + oxygen |
| B | potassium + bromine \rightarrow potassium bromide |
| C | copper sulfate + iron \rightarrow iron sulfate + copper |
| D | hydrogen + chlorine \rightleftharpoons hydrogen chloride |

Match each statement with one of the reactions by writing **A**, **B**, **C** or **D** in the box.

You may use the letters once, more than once, or not at all.

(a) The reversible reaction.

[1]

The reversible arrow was well known, C also proved to be a popular response.

Question 11 (b)

(b) The reaction of a very reactive metal.

[1]

Higher attaining candidates chose potassium. A was the most popular incorrect response.

Question 11 (c)

(c) The reaction of a green gas.

[1]

More successful candidates appreciated that chlorine is a green gas. All responses were seen, with A being the most popular.

Question 11 (d)

(d) The reaction where a more reactive metal displaces a less reactive metal.

[1]

More successful candidates chose iron displacing the copper in copper sulfate. Many candidates chose B since potassium is a reactive metal.

Question 11 (e)

(e) The reaction where a metal is extracted using electrolysis.

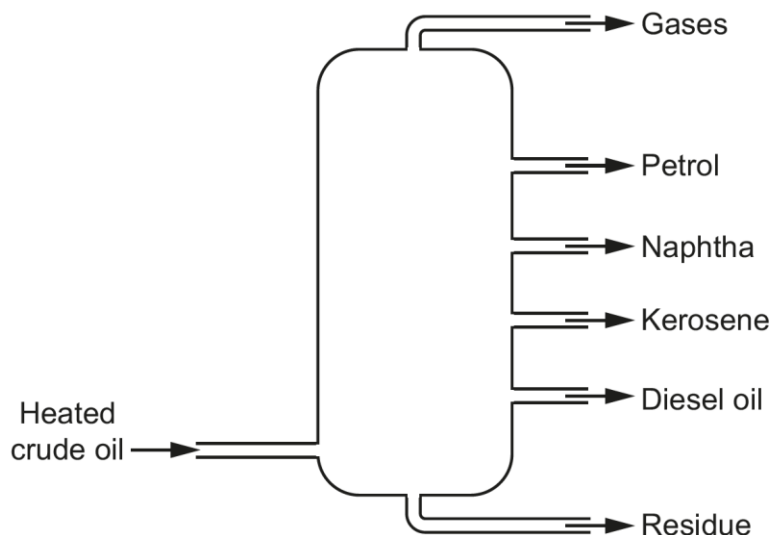
[1]

More successful candidates knew that aluminium is extracted by electrolysis, C was the most popular response.

Question 12 (a) (i)

12 (a) Fig. 12.1 shows the separation of the chemicals found in crude oil.

Fig. 12.1



(i) What is the name of the process shown in Fig. 12.1?

..... [1]

Many candidates recognised that the process involves distillation, with the highest attaining candidates appreciating that this distillation needs to be fractional distillation. Cracking, evaporation, vaporisation, separation, extraction, crude oil, blast furnace and names of fractions were all popular responses.

Question 12 (a) (ii)

(ii) Crude oil is heated and vaporised as it enters the column.

Describe what happens to the vapours as they rise up the column.

.....

 [2]

Candidates found this very challenging. They tended to answer the question by referring to separation by boiling point with the crude oil vaporising, rising up the column and the gases at the top having the highest temperature and boiling point since they are gases.

Question 12 (a) (iii)

(iii) Which of the chemicals separated from crude oil has the **smallest** molecules?

Tick (✓) **one** box.

- | | |
|---------|--------------------------|
| Gases | <input type="checkbox"/> |
| Naphtha | <input type="checkbox"/> |
| Residue | <input type="checkbox"/> |

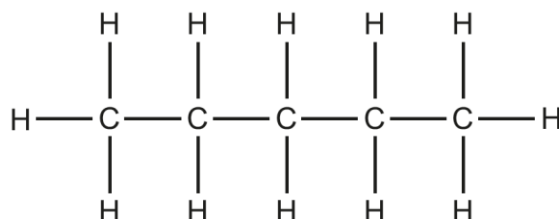
[1]

All three responses were popular with residue being the most popular.

Question 12 (b) (i)

(b) Fig. 12.2 shows the structure of a molecule found in crude oil.

Fig. 12.2



(i) Which words describe the molecule?

Tick (✓) **two** boxes.

- | | |
|-------------|--------------------------|
| Alkane | <input type="checkbox"/> |
| Hydrocarbon | <input type="checkbox"/> |
| Mixture | <input type="checkbox"/> |
| Polymer | <input type="checkbox"/> |

[2]

Hydrocarbon was well known, both mixture and polymer were popular incorrect responses. A large number of candidates ticked only one box.

Assessment for learning



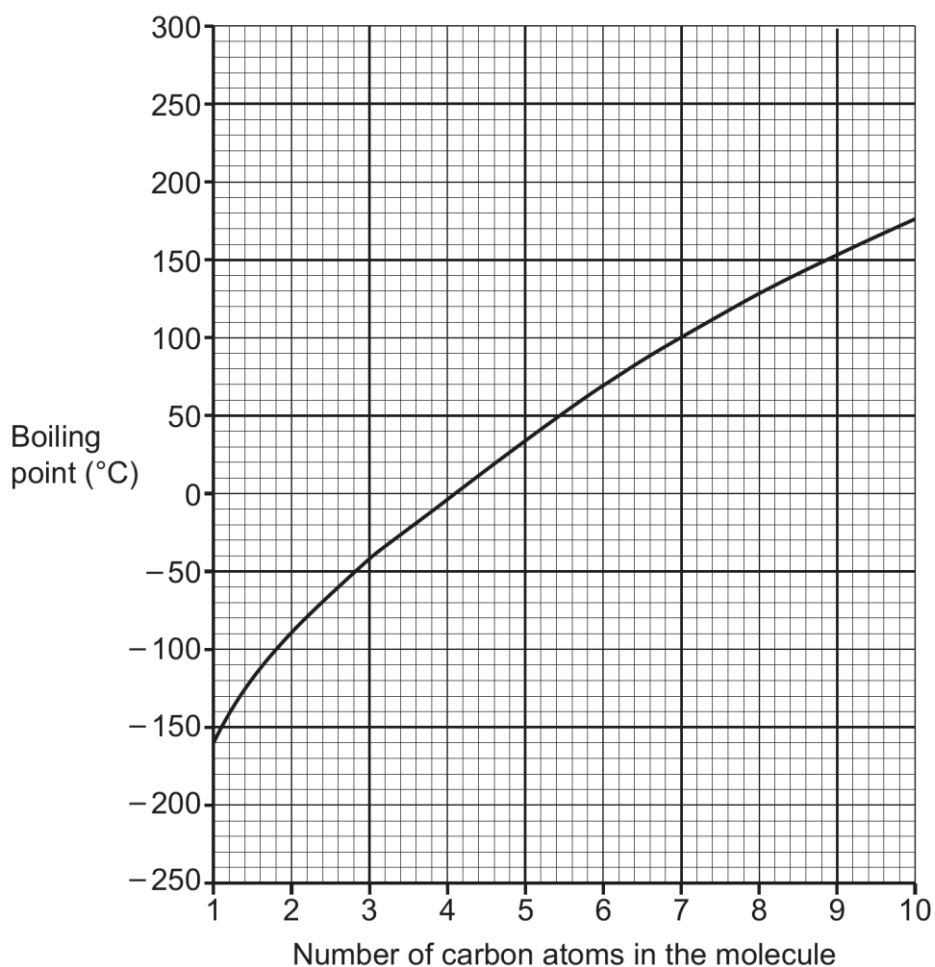
It is imperative that candidates read questions carefully to make sure they answer what has been asked, for example ticking the correct number of boxes.

Question 12 (b) (ii)

- (ii) There are other molecules similar to **Fig. 12.2** but with different numbers of carbon atoms.

Fig. 12.3 shows how the boiling point of these molecules changes with the number of carbon atoms in the molecule.

Fig. 12.3



Use the graph to estimate the boiling point of the molecule shown in **Fig. 12.2**.

Boiling point = °C [1]

More successful candidates went back to the molecule in Fig. 12.2, counted 5 carbon atoms and then used the graph to estimate its boiling point. Many candidates read the temperature where the line crossed the y-axis. A large number of responses guessed temperatures which were not covered by the graph.

Question 12 (c)

(c) 160 litres of crude oil contains 75 litres of petrol.

Calculate the percentage of petrol in the crude oil.

Give your answer to **2** significant figures.

Percentage of petrol = % [3]

More successful candidates showed their working and gave their answer correctly rounded and to 2 significant figures. A significant number gave the calculator value. Quite a large number carried out an inverted division. Many candidates did not show any working, and so an incorrect answer could not gain any possible error carried forward marks.

Exemplar 1

$$160 \div 75 \times 100 \\ = 213.\dot{3}$$

~~$$160 \times 75 \\ = 12000 \\ = 120$$~~

Percentage of petrol =210..... % [3]

The calculation in Exemplar 1 has the division inverted and so does not score marking point one. The evaluation of their calculation to many significant figures is given, marking point two, and then this is correctly quoted to 2 significant figures, marking point 3. By showing the working this incorrect answer scored 2 marks.

Assessment for learning



Working should be shown in all calculations so that incorrect responses may be able to gain working marks or error carried forward marks.

Question 13 (a)

13 Lithium, sodium and potassium are metals in Group 1 of the Periodic Table.

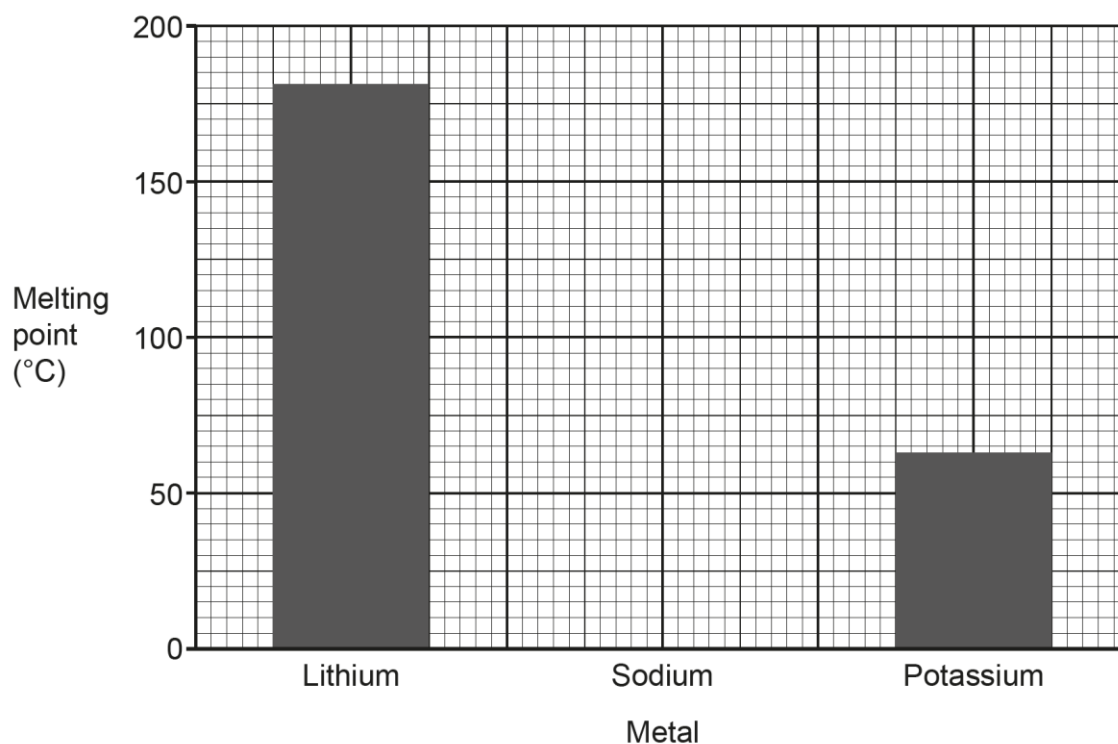
Table 13.1 shows the melting points of lithium, sodium and potassium.

Table 13.1

| Metal | Melting point (°C) |
|-----------|--------------------|
| lithium | 181 |
| sodium | 98 |
| potassium | 63 |

(a) Complete the bar chart to show the melting point of sodium.

[1]



Many candidates used the information and drew the bar correctly, 90 °C and 90 - 94 °C were also popular. It is advisable to draw the bar in pencil, so that errors may be erased. A significant number of candidates had several attempts at drawing the bar to the correct height, but since these were all drawn in pen, it was impossible to see which one was the final answer.

Question 13 (b)

- (b) State and explain which of the metals lithium, sodium or potassium is the softest. Use information from **Table 13.1**.

Metal

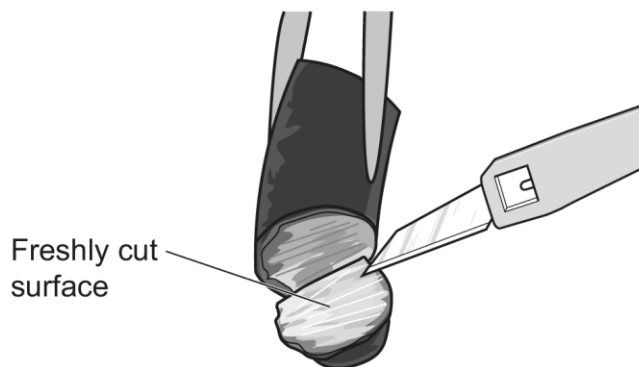
Reason

..... [2]

Many candidates interpreted the information correctly choosing potassium, with the higher attaining citing the lowest melting point as the reason. Lower melting point and low melting point were popular as was discussing the boiling point.

Question 13 (c) (i)

- (c) Lithium, sodium and potassium can be cut with a knife as shown in the diagram.



At first the freshly cut surface looks shiny, but then begins to go dull.

- (i) Complete **Table 13.2** by estimating the times for lithium and potassium surfaces to go dull.

Table 13.2

| Metal | Time for freshly cut surface to go dull (s) |
|-----------|---|
| lithium | |
| sodium | 17 |
| potassium | |

[1]

The trend in reactivity was generally well known, reversing the trend was also popular. A significant number gave negative values for the times.

Question 13 (c) (ii)

- (ii) Lithium, sodium and potassium are stored in oil to prevent them reacting with gases in the air.

Which gases in the air react with lithium, sodium and potassium?

Tick (✓) **two** boxes.

Argon

Nitrogen

Oxygen

Water vapour

[2]

Oxygen was well known; nitrogen was a popular incorrect choice. A large number of candidates ticked only one box.

Exemplar 2

Petrol has a less chance of combusting sulfur dioxide, which decreases the chance of acid rain, and will help the environment.

However it has more carbon dioxide than diesel, which will increase the temperature in the atmosphere, causing global warming and climate change and will affect the environment due to loss of habitats because of extreme flooding.

[6]

This answer in Exemplar 2 has the advantage of less SO_2 and decreases acid rain. It also has more CO_2 causing global warming, climate change, flooding and loss of habitat. This is a comprehensive Level 3, 6-mark, answer citing an advantage and disadvantage and explaining the environmental consequence of each with great detail for carbon dioxide.

Exemplar 3

one advantage of using petrol as fuel is that there is less sulfur dioxide which means that there will be less air pollution however one disadvantage is that there is more carbon dioxide, carbon monoxide and oxides of nitrogen in petrol than diesel. This is a disadvantage because of greenhouse gases and CO₂ in the air. This is why petrol is cheaper than diesel.

The response in Exemplar 3 has the advantage of less SO₂ but just 'less air pollution' is not a creditworthy explanation of an environmental consequence. This response mentions more CO₂, CO and NO_x and has then linked global warming to the CO₂ as an environmental consequence. This response cites an advantage and a disadvantage, it and gives one example of the consequence of the disadvantage. Where there is no environmental consequence of the advantage the answer is not Level 3. This answer is Level 2, 4 marks.

Question 15 (a) (i)

15 In industry, iron can be extracted from iron ore. Iron ore contains iron oxide, Fe₂O₃.

(a) Iron is extracted from iron oxide by reduction.

The equation for one reaction is



(i) Complete the **balanced symbol** equation for the reaction.

[2]

Many candidates cited 2 for Fe with the most successful candidates also citing 3 for CO. 6 for CO was a common response. A significant number of candidates didn't answer this question.

Question 15 (a) (ii)

(ii) Why does this reaction happen?

Tick (✓) **one** box.

Carbon and iron have the same reactivity.

Carbon is more reactive than iron.

Iron is more reactive than carbon.

[1]

Iron being more reactive than carbon was a very popular response.

Question 15 (a) (iii)

(iii) Explain how the equation shows that the iron oxide is reduced.

.....
..... [1]

Candidates found this very challenging. Many quoted the products of the reaction or repeated the stem of the question. OILRIG was often quoted, but either not applied, or applied incorrectly. A significant number omitted this question.

Question 15 (a) (iv)

(iv) Which chemical reduces the iron oxide, Fe_2O_3 ?

Tick (✓) **one** box.

C

Fe

CO

[1]

Carbon monoxide was the most popular response.

Question 15 (b)

(b) Iron can be recycled in 5 stages.

Stage 1 Different types of waste metals are put in a recycling bin.

Stage 2 These waste metals are collected.

Stage 3

Stage 4 The iron is compressed and shredded.

Stage 5 The iron is melted and formed into new products.

Describe what happens in **Stage 3**. Write your answer on the line next to **Stage 3**.

[1]

More successful candidates appreciated that this is the point in the process where the metals are sorted into different types. Landfill, recycling, shredding, compressing and cleaning were all popular responses.

Question 15 (c) (i)

(c) In industry, iron is extracted from iron ore in a blast furnace.

The table shows information about the production of iron in a blast furnace and from recycling.

| In a blast furnace | From recycling |
|--|--|
| 1 tonne of iron ore makes 0.63 tonnes of iron | 1 tonne of recycled iron makes 0.96 tonnes of iron |
| 2×10^7 kJ of energy is needed to make 1.0 tonne of iron | 5×10^6 kJ of energy is needed to make 1.0 tonne of iron |

(i) Give **two** reasons why it is better to produce iron from recycling than in a blast furnace.

Use the information from the table.

- 1
-
- 2
-

[3]

More successful candidates interpreted the table correctly. Very few candidates responded with the detail required for a question worth 3 marks, and so there needed to be a comparison in terms of the quantities used, such as recycling uses four times less energy or produces 0.33 more tonnes of iron.

Look at the number of marks available for a question

Looking at the mark allocation of a question gives information on the amount the candidate needs to write to access all of the marks.

Question 15 (c) (ii)

- (ii) Calculate the mass of iron made from 250 tonnes of iron ore in the blast furnace. Give your answer in kilograms.

(1 tonne = 1000 kg)

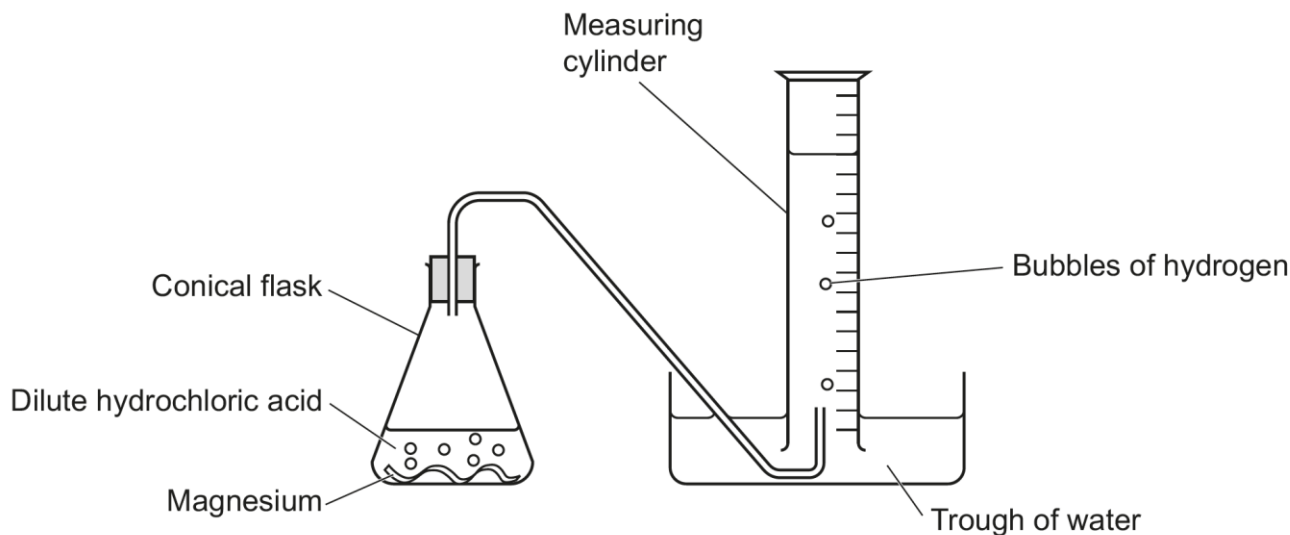
Mass of iron = kg [2]

The more successful candidates both calculated the reacting mass and did the unit conversion. Many candidates misread the question and only converted the 250 tonnes (the mass of the **iron ore**) into kg.

Question 16 (a)

16 A student investigates the rate of reaction between magnesium and an **excess** of dilute hydrochloric acid.

The diagram shows the apparatus they use.

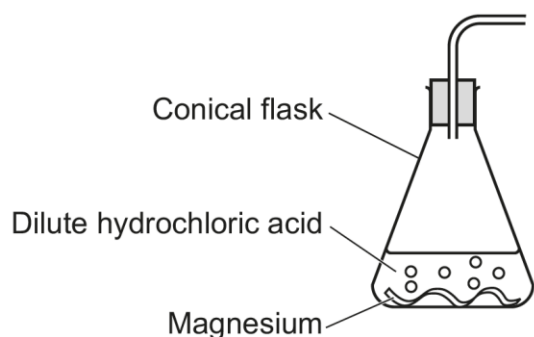


(a) The student has difficulty filling the measuring cylinder with water.

They change the measuring cylinder for a different piece of apparatus which allows them to measure the volume of hydrogen more accurately.

Name the piece of apparatus they use and complete the diagram below to show this apparatus.

Name of piece of apparatus

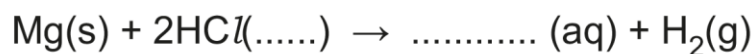


[3]

The most successful candidates named a gas syringe; other popular responses included: test-tube, measuring cylinder, flask and scale. A very small number of the very highest achieving completed the diagram correctly. Most candidates omitted the drawing or repeated the drawing from the question stem. A large number of candidates omitted the whole of the question.

Question 16 (b)

(b) Complete the **balanced symbol** equation for the reaction.



[2]

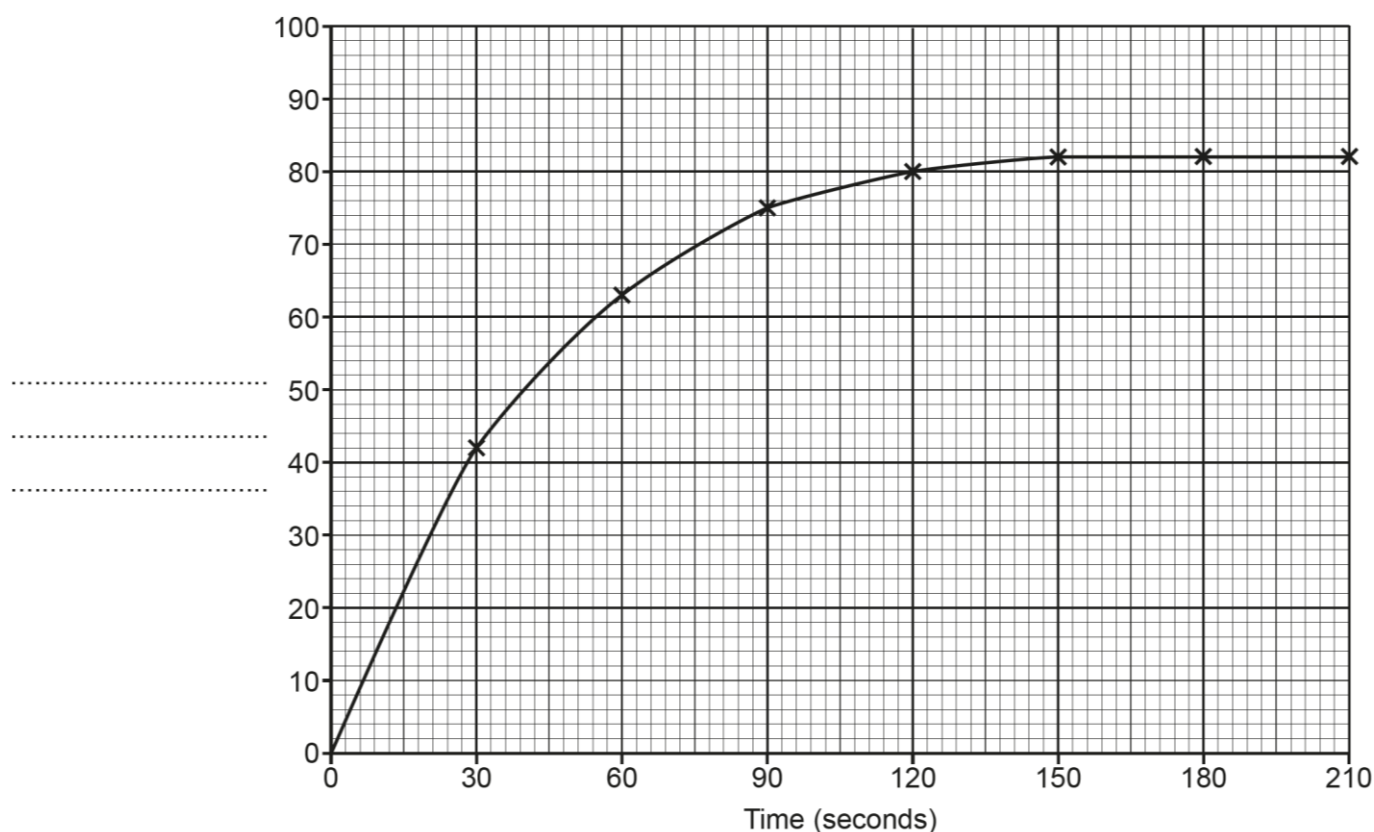
Candidates found this very challenging and many didn't answer the question. Of the two answers, (aq) was seen more frequently than MgCl_2 . The most popular state was (g) with MgCl , Mg and Cl being popular products.

Question 16 (c)

(c) The student records the results of the experiment every 30 seconds. The graph shows the student's results.

Write the correct label, including the units, for the y-axis on the graph.

[2]



The most successful candidates gave the correct unit for the axis often alongside rate, reaction, concentration of acid and amount of bubbles. Temperature and $^{\circ}\text{C}$ was a popular response. Many candidates didn't answer the question.

Question 16 (d)

- (d) The student repeats the experiment. The only difference is they use a **higher** concentration of acid.

Draw a line on the graph to show the results of this experiment.

[2]

More successful candidates drew a steeper line, but usually with the volume of gas being higher. Many candidates didn't answer the question.

Question 16 (e)

- (e) If the experiment is repeated at a **higher** temperature, the rate of reaction increases.

Explain why. Use ideas about particles and collisions.

.....

.....

.....

.....

.....

.....

..... [3]

Candidates found this very challenging and many omitted the question or repeated the question stem without adding to it. Particles moving more quickly was the marking point most frequently seen, particles moving more or the acid having more energy were popular non-creditworthy responses. Some discussed collisions often in terms of more collisions rather than increased frequency and increased successful collisions. References to activation energy were rare, and they were often in terms of the particles having more activation energy.

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