

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250

For first teaching in 2016

J250/04 Summer 2024 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

J250/04 is the fourth of six foundation papers for Gateway Combined Science A and examines the Chemistry content of Topics C4, C5 and C6 with assumed knowledge of C1, C2 and C3.

To do well on this paper, candidates need to demonstrate knowledge and understanding of scientific ideas and application of this knowledge.

The final question on the paper overlapped with the Higher tier paper. This proved to be very challenging for candidates, with several parts of the question omitted.

There were several numerical calculations on the paper and more candidates are showing their working than in previous years.

It is important for candidates to look at the marks available for a particular question and use this to help guide for the length and depth of answer required.

It is advisable for candidates to check their responses to make sure that they have answered all of what is being asked, e.g. that numerical answers are given to an appropriate number of significant figures or decimal places and that written responses cover all aspects of the question.

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, stated the conditions required for a faster reaction, and explained how these factors affected the ratecalculated percentages, Questions 13 (a) and 16 (c), and quoted their answer to the required number of significant figuresinterpreted reaction data in order to place elements in order of reactivity, Questions 12 (a), 12 (b) and 12 (c)plotted a graph and drew a curve of best-fit, Questions 12 (c) (i) and (c) (ii), and interpreted graphical results Question 14showed understanding of separation techniques Questions 11 (a), 11 (b), 12 (b) (i) and (b) (ii).	<ul style="list-style-type: none">could not describe a trend in negative temperatures Question 12 (d) (i)were unable to interpret an equilibrium reaction to construct an equation Question 13 (b) (ii)could not describe a test to compare acidity of two solutions, Question 13 (d) (ii)confused several aspects of organic chemistry, Question 14misinterpreted life-cycle assessment and recycling, Questions 16 (a) and (b).

Section A overview

Section A consists of 10 Multiple Choice questions. Almost all questions were completed by candidates with only Question 9 showing a very small number of omissions.

There was often evidence on the paper of candidates working out their response.

Questions on pollution (1), enzymes (2) and photosynthesis (5) were particularly well answered.

Questions on conservation of mass (4) and interpreting the results of reactions in terms of reactivity (7) proved to be more challenging for candidates.

Question 1

1 What is an effect of increased levels of carbon dioxide in the Earth's atmosphere?

- A Acid rain
- B Global warming
- C Light pollution
- D Smog

Your answer

[1]

The environmental effects of carbon dioxide were well known by over three quarters of candidates. The acidic nature of carbon dioxide caused some to choose A, which was the more popular incorrect response.

Question 2

2 What are catalysts found in biological systems called?

- A Bacteria
- B Enzymes
- C Isotopes
- D Vitamins

Your answer

[1]

Enzymes were known. C and D were popular incorrect responses.

Question 3

3 Burning fossil fuels can produce **solids** called particulates.

Which product of burning fossil fuels is an example of a particulate?

- A Carbon
- B Carbon monoxide
- C Nitrogen dioxide
- D Sulfur dioxide

Your answer

[1]

Candidates found this challenging. Many opted for B or D which can both be products of burning fossil fuels but are gases rather than particulates.

Question 4

4 The word equation shows how iron is extracted from iron oxide.

iron oxide + carbon \rightarrow iron + carbon dioxide

The table shows the masses of the reactants and products.

	Iron oxide	Carbon	Iron	Carbon dioxide
Mass (tonnes)	3200	360		1320

What is the mass of iron produced?

- A 1880 tonnes
- B 2240 tonnes
- C 2840 tonnes
- D 4880 tonnes

Your answer

[1]

Just over half of candidates calculated the mass correctly. All other responses were seen in approximately equal numbers.

Question 5

- 5 Scientists think the Earth's oxygen-rich atmosphere developed due to photosynthesis by plants.

Which gas in the Earth's early atmosphere did plants absorb during photosynthesis?

- A Ammonia
- B Carbon dioxide
- C Methane
- D Sulfur dioxide

Your answer

[1]

Just over half of candidates chose carbon dioxide. C was the most popular incorrect response.

Question 6

- 6 It is thought that the gases in Earth's early atmosphere were released by volcanoes.

The table shows the amounts of different gases released by a volcano.

Which of the gases are carbon dioxide and water vapour?

Gas	Percentage of gas (%)
W	64
X	8
Y	2
Z	26

- A W and Z
- B W and Y
- C X and Y
- D X and Z

Your answer

[1]

Candidates found this question challenging. C and D were the more popular incorrect responses.

Question 7

7 A student adds some metals to different solutions.

The table shows their results.

Metal	Solution	Reaction
Copper	nickel sulfate	X
Nickel	tin sulfate	✓
Tin	copper sulfate	✓

Key:
✓ = reaction
X = no reaction

What do the results tell the student about the reactivity of the three metals?

- A All three metals have the same reactivity.
- B Copper is the most reactive metal.
- C Nickel is the most reactive metal.
- D Tin is the most reactive metal.

Your answer

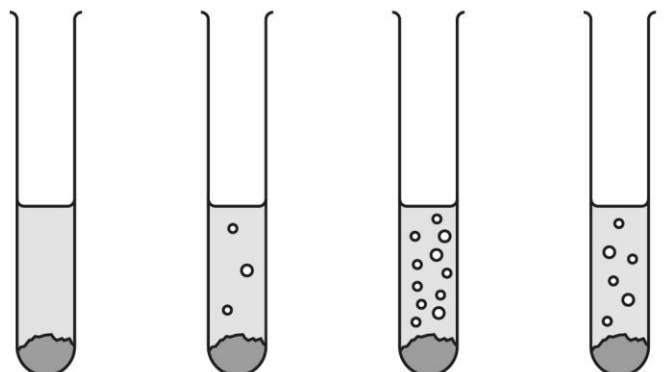
[1]

Candidates found analysing displacement data challenging. D was the most popular incorrect response.

Question 8

8 Four different metals are placed into dilute hydrochloric acid.

Which metal forms positive ions **most** easily?



Metal A

Metal B

Metal C

Metal D

Your answer

[1]

Most candidates linked reactivity to the number of bubbles correctly.

Question 9

9 Carbon reacts with copper oxide to produce copper.

copper oxide + carbon → copper + carbon dioxide

What is the role of the carbon?

- A It is a catalyst.
- B It neutralises the copper oxide.
- C It oxidises the copper oxide.
- D It reduces the copper oxide.

Your answer

[1]

All responses were seen in approximately equal numbers.

Question 10

10 A teacher investigates some reactions of chlorine.

Why is it important that the teacher does **not** breathe in chlorine?

- A** Chlorine is highly flammable.
- B** Chlorine is inert.
- C** Chlorine is strongly alkaline.
- D** Chlorine is toxic.

Your answer

[1]

The toxicity of chlorine was known by just over half of the candidates. C was the most popular incorrect response.

Section B overview

Many candidates attempted all of the questions but some either omitted the questions they found more challenging or rewrote the stem of the question as their answer. Answers sometimes lacked detail. Several candidates highlighted key words in a question which aided them in answering all aspects of the question, for example where the answer to a calculation needed to be given to a specific number of significant figures. The use of 'it' in answers often confuses what an answer is trying to communicate, for example in comparing reactivities of elements.

Questions on separation and potability of water (Question 11), reversible reactions (Question 13 (b)), plotting graphs (Question 13 (c) (i)) and use of electrolysis for the extraction of aluminium were particularly well answered.

Questions on testing water sample for level of acidity (Question 13 (d) (ii)), organic chemistry (Question 14), recycling (Question 16 (b)) and relative reactivities and extraction (Question 16 (e) (iii)) proved to be the most challenging for candidates.

Question 16 was the overlap question with the Higher tier.

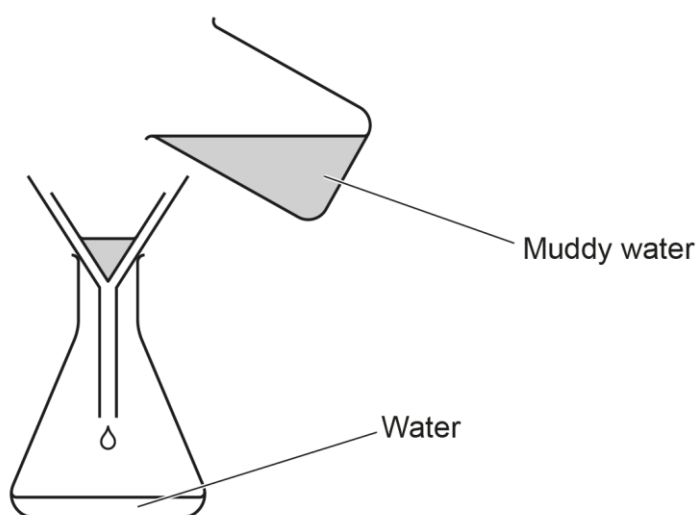
There was no evidence that candidates did not have enough time to complete the paper.

Question 11 (a) (i)

11 A student does some experiments to separate water from muddy water.

(a) Fig. 11.1 shows the equipment the student uses in their first experiment.

Fig. 11.1



(i) What is the name of this separation technique?

..... [1]

The technique of filtration was well known by over three quarters of candidates. Distillation was the most popular incorrect response with crystallisation seen occasionally.

Question 11 (a) (ii)

(ii) The water produced in the experiment is a very light brown colour.

Why is the student **not** sure that the water produced is **potable**?

Tick (✓) **two** boxes.

Only small amounts of water are produced.

☐

The experiment takes too long.

☐

The water may contain bacteria.

☐

The water may contain tiny particles of mud.

☐

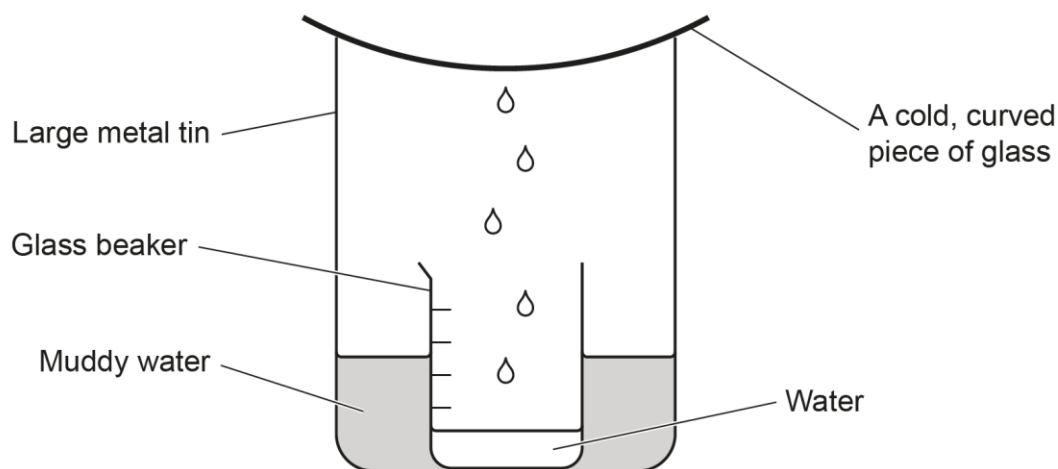
[2]

Many candidates ticked just one box instead of two. Water containing tiny particles of mud was the most common and correct response, and the presence of bacteria was quite well known. Many considered the technique rather than the potability of the water as seen by boxes 1 and 2 being common responses.

Question 11 (b)

(b) Fig. 11.2 shows the equipment the student uses in their second experiment.

Fig. 11.2



The student leaves the equipment in a sunny place.

The statements describe how the experiment produces water.

The statements are **not** in the correct order.

- A The water drips into the beaker.
- B The sun heats up the muddy water.
- C The water evaporates.
- D The water vapour cools and condenses.
- E The water vapour rises upwards.
- F The water vapour touches the cold piece of glass.

Write the remaining letters in the boxes to show the correct order of the statements.

B → → **E** → → → **A**

[2]

Many candidates understood the processes and gave the three remaining processes in the correct order. Placing C before F was the most common correct response, many candidates placed D cooling and condensing before F the water touching the cold glass. A significant number of candidates reversed the order.

Question 12 (a)

12 This question is about Groups 1, 7 and 0 in the Periodic Table.

(a) What are the properties of the elements in Group 1, Group 7 and Group 0?

Tick (✓) **one**, **two** or **three** boxes in each row in **Table 12.1**.

Table 12.1

Properties	Group 1	Group 7	Group 0
They are non-metals.			
They are soft solids.			
They form coloured gases.			

[3]

Candidates found this quite challenging, often placing one tick for non-metals, usually for group 0; two ticks for solids, usually groups 1 and 7, and two ticks for coloured gases, usually groups 7 and 0. The properties of group 7 were better known than those of groups 1 and 0.

Question 12 (b)

(b) A teacher does an experiment to show that the order of reactivity going down Group 1 is:



- The teacher has pieces of the Group 1 elements of the same size.
- They react these with water.
- They then time how long it takes for the pieces to disappear.

Table 12.2 shows their results.

Complete **Table 12.2** by writing lithium, sodium and potassium in the correct spaces.

Table 12.2

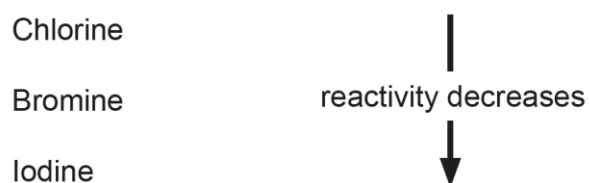
Group 1 element	Time to disappear (s)
.....	4
.....	21
.....	12

[2]

Many candidates seemed to confuse time to disappear with rate of reaction and hence reactivity of the metal. Sodium, lithium, potassium was the most common incorrect response where only the middle metal was correct. All combinations were also seen.

Question 12 (c)

(c) The teacher also does an experiment to show that the order of reactivity going down Group 7 is:



They react gases of each Group 7 element with small pieces of hot iron and write down their observations.

Table 12.3 shows their results.

Complete **Table 12.3** by writing chlorine, bromine and iodine in the correct spaces.

Table 12.3

Group 7 element	Observation
.....	The iron glows brightly.
.....	The iron glows very brightly.
.....	The iron glows only slightly.

[2]

Many candidates analysed the information and gave the correct order of reactivity of the group 7 elements. Chlorine, bromine, iodine was the most common incorrect response where only the placement of iodine was correct. All combinations were seen.

Question 12 (d) (i)

(d) Table 12.4 shows the boiling points of some Group 0 elements.

Table 12.4

Element	Boiling point (°C)
Helium	−269
Neon	−246
Argon	
Krypton	−152
Xenon	−108

(i) Describe what happens to the boiling points going from helium to xenon.

..... [1]

The use of negative numbers proved challenging for many candidates who considered only the numbers and thought the trend decreased.

Question 12 (d) (ii)

(ii) Estimate the boiling point of argon. Use the information in Table 12.4.

..... [1]

Almost three quarters of candidates had a temperature in the range. Most others had a number in the correct range but omitted the negative sign.

Question 13 (a)

13 Nitrogen is a gas found in the Earth's atmosphere.

(a) The table shows the percentages of different gases found in the Earth's atmosphere.

Gas	Percentage in the Earth's atmosphere (%)
Nitrogen	
Oxygen	20.95
Carbon dioxide	0.38
Other gases	0.92

Calculate the percentage of nitrogen in the Earth's atmosphere.

Percentage of nitrogen = % **[2]**

Candidates performed this calculation well. More showed their working this year and so error carried forward marks were able to be awarded, although a significant number gave an incorrect answer with no working. The most common error was not subtracting the summed percentages from 100.

Calculations

It is really important that candidates show their working in calculations, otherwise it is impossible to award partial marks for responses where only one step is incorrect.

Question 13 (b) (i)

(b) Nitrogen reacts with hydrogen to form ammonia.

The word equation for the reaction is:

nitrogen + hydrogen \rightleftharpoons ammonia

(i) Describe how the word equation shows that the reaction is reversible.

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

The meaning of the equilibrium arrows was well known. Incorrect responses included rewriting the equation or an equals sign.

Question 13 (b) (ii)

(ii) The word equation for the **forward** reaction is:

nitrogen + hydrogen \rightarrow ammonia

Write the **word** equation for the **backward** reaction.

..... [1]

Just over half of candidates wrote the reverse reaction. Many others appeared to use algebra skills to produce equations with reagents and or products being subtracted from each other, e.g. ammonia – hydrogen \rightarrow nitrogen or ammonia – nitrogen \rightarrow hydrogen. Some repeated the equation in the question.

Question 13 (c) (i)

(c) This table shows the percentage of ammonia produced in the reaction at different pressures.

Pressure (atmospheres)	Percentage of ammonia (%)
0	0
100	22
200	40
300	54
400	62
500	66

(i) Plot the data from the table on the graph.
The first two points are already plotted.

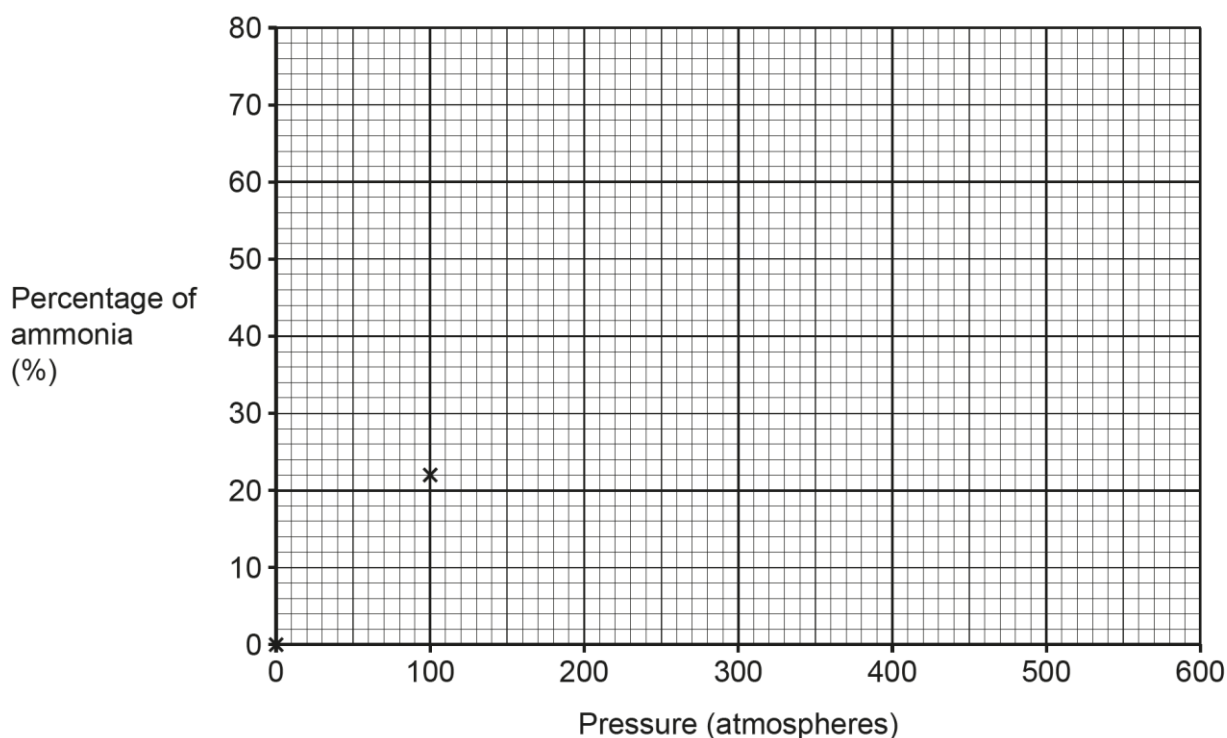
[2]

The vast majority of candidates plotted the four points correctly. Incorrect responses included plotting 64 instead of 62 and 56 instead of 54.

Question 13 (c) (ii)

(ii) Draw the curve of best fit.

[1]



Many candidates seemed to find drawing the curve challenging. Multiple lines, feathery lines, point-to-point lines drawn with a ruler, not including the point at the origin, and straight lines missing all of the points were all quite common.

Question 13 (d) (i)

(d) Oxides of nitrogen released from cars cause acid rain.

(i) Oxides of nitrogen responsible for acid rain are given the formula NO_x .What is the value of x in nitrogen dioxide?

..... [1]

The meaning of the prefix 'di' was not well understood. 3 was a common response as was a whole variety of large numbers.

Question 13 (d) (ii)

(ii) Normal rain water is slightly acidic.

Describe a test and its result to show that acid rain is **more** acidic than normal rain water.

Test

.....

Result

.....

.....

[2]

Candidate found this very challenging with the higher performing candidates overall appreciating the need for Universal Indicator or a pH meter. Those that used Universal Indicator often referred to higher pH for the more acidic substance or had rainwater turning the indicator blue or purple.

Many candidates discussed adding the liquids to stone or to metals and seeing which reacted faster or putting them on a hand to see which burned the fastest or the hottest.

Misconception



Many candidates thought that litmus or methyl orange could indicate whether a substance was more acidic than another without appreciating that these indicators only test whether a substance is acidic or alkaline.

The colours and the pH values obtained using Universal Indicator were not well known, with a more acidic substance having a higher pH.

Exemplar 1

Test Use universal indicator on the acid rain and rain water

Result the acid rain will turn an orange-red colour and the rain water a blue-green colour

The candidate has correctly chosen Universal Indicator.

The first part of the result is correct in that the acid rain will turn the indicator orange-red. However, this is contradicted by the normal rainwater turning the Universal Indicator blue-green as the question states that normal rainwater is a weak acid.

This answer scores 1 mark.

Question 14 (a)

14 Crude oil is a source of useful chemicals called hydrocarbons.

(a) Complete the sentence about crude oil.

Put a ring around the correct option.

Crude oil is a **compound / feedstock / renewable resource** used by the petrochemical industry.

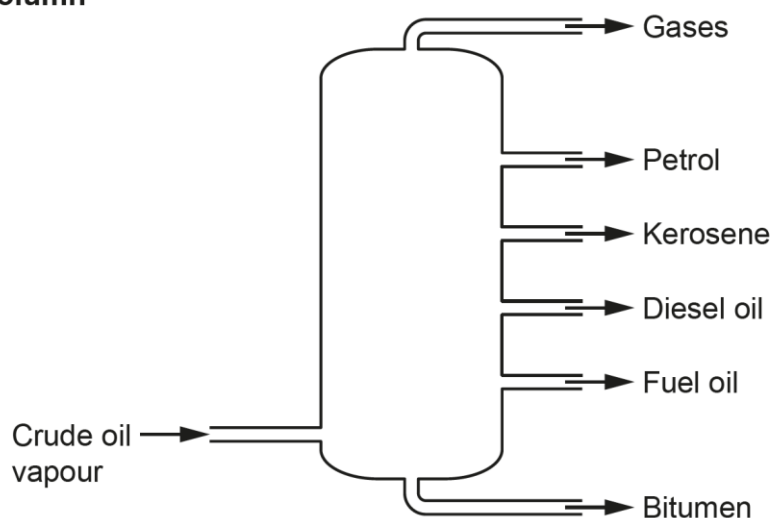
[1]

A very small number of candidates understood the term feedstock. Compound and renewable resource were seen in approximately equal amounts.

Question 14 (b) (i)

(b) The diagram shows the fractionating column used in the fractional distillation of crude oil.

Fractionating Column



(i) Which state symbol describes the crude oil as it enters the fractionating column?

Tick (✓) **one** box.

(g) ☐

(l) ☐

(s) ☐

[1]

Almost half of candidates appreciated that vapour was synonymous with gas. Liquid was the most common response. A small number of candidates thought solid.

Question 14 (b) (ii)

(ii) Write an **X** on the fractionating column where it is **coolest**.

[1]

Many candidates either put the X at the bottom of the column or outside of the column.

Question 14 (c) (i)

(c) The table shows the boiling point of four hydrocarbons.

Hydrocarbon	Boiling point (°C)
P	69
Q	126
R	36
S	98

(i) Which of the hydrocarbons **P**, **Q**, **R** or **S** is produced nearest to the **top** of the fractionating column?

..... [1]

Half of candidates appreciated that the top of the fractionating column was the coolest and so chose R. Many had the temperature gradient in the column reversed and so Q was the most common incorrect response. P and S were seen but not commonly.

Question 14 (c) (ii)

(ii) Which of the hydrocarbons **P**, **Q**, **R** or **S** has the **largest** molecules?

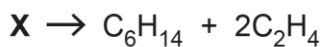
..... [1]

Many candidates linked the size of the molecule to its position on the fractionating column. Many reversed the trend and gave the incorrect response R.

Question 14 (d) (i)

(d) Large hydrocarbons can be made more useful by cracking.

The equation shows the cracking of hydrocarbon **X**.



(i) What is the formula of hydrocarbon **X**?

..... [1]

The very highest performing candidates overall gave a correct formula and many candidates omitted the question. Many candidates omitted to take account of the 2 before the ethene molecule and so gave the answer C_8H_{18} . Some listed the elements with no attempt at a formula.

Question 14 (d) (ii)

(ii) Which homologous series of hydrocarbons does C_6H_{14} belong to?

..... [1]

Very few candidates knew the homologous series alkenes and almost half of candidates omitted the question. A small number gave alkane and other responses appeared to be random.

Question 14 (d) (iii)

(iii) The hydrocarbon C_2H_4 belongs to a different homologous series.

Suggest the **general formula** of the homologous series that contains C_2H_4 .

Tick **one** (✓) box.

C_nH_n ☐

C_nH_{2n} ☐

C_{2n}H_n ☐

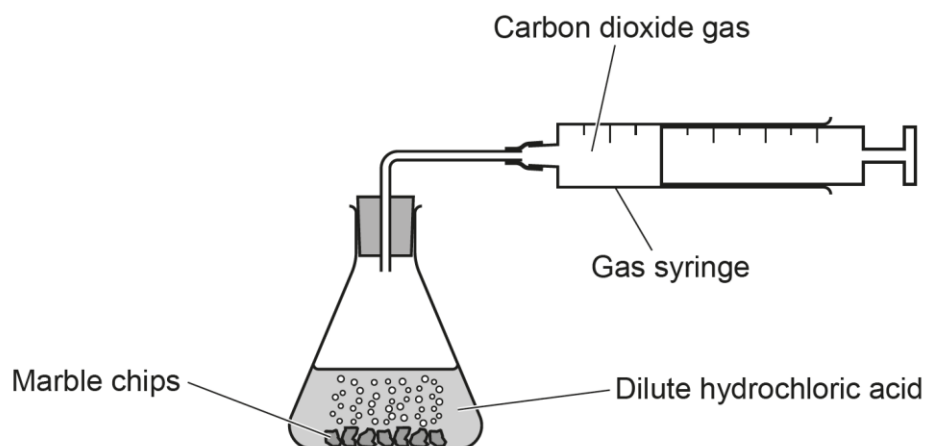
[1]

Over half of candidates chose the correct general formula. C_{2n}H_n was more commonly seen than C_nH_n .

Question 15*

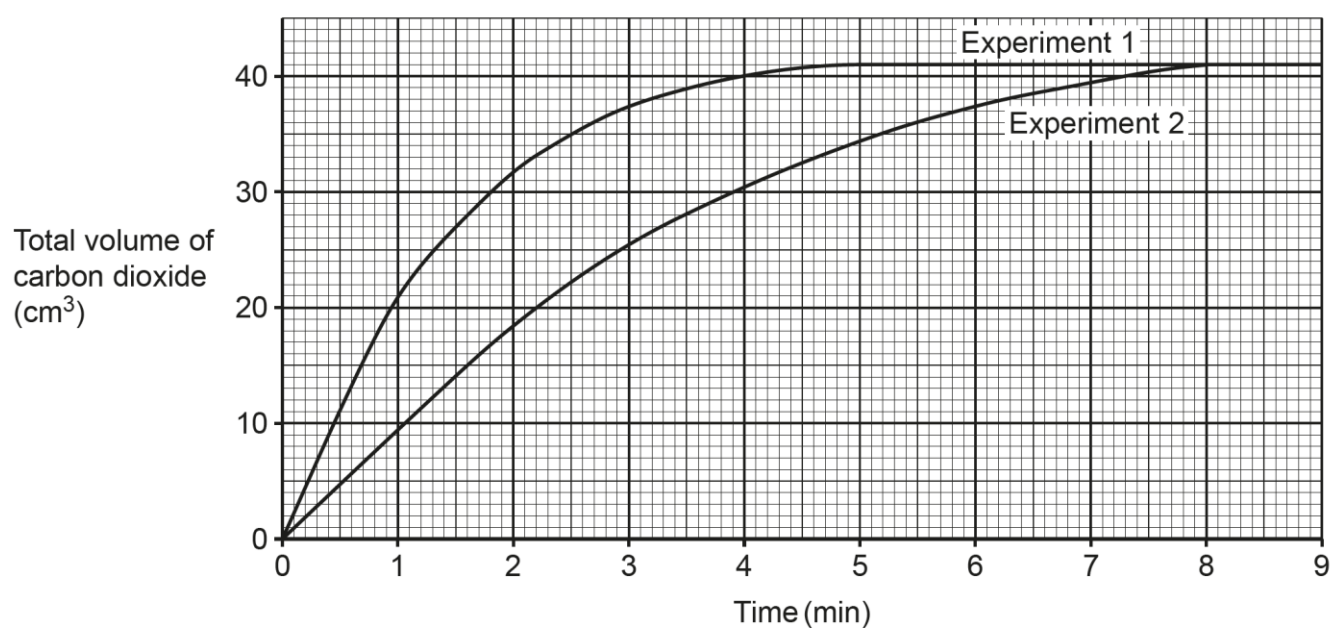
15* A student investigates the rate of reaction between pieces of marble chips and an excess of dilute hydrochloric acid.

The diagram shows the equipment they use.



The student measures the total volume of carbon dioxide gas produced every minute until the reaction finishes.

They do two different experiments and plot a graph of the results.



Which experiment has the greater rate of reaction?

Explain your answer by including:

- information from the graph
- a description of how the experiments might be different
- ideas about the reacting particle model including particles and their collisions.

.....

.....

.....

.....

.....

..... [6]

Level 1 required either Experiment 1 or Experiment 2 to be chosen and have a basic explanation for their choice. Level 2 required either Experiment 1 or Experiment 2 to be chosen and have a more detailed explanation of their choice. Level 3 required Experiment 1 to be chosen and have a clear explanation for their choice which included comments about the graph, the conditions and the reasons why the conditions increased the rate.

Almost all candidates chose Experiment 1 as having the greater rate of reaction. Many gave basic explanations from the graph and so 2 or 3 marks were common. Candidates found the conditions more challenging often referring to more chips or more acid rather than surface area or size of the chips and concentration of the acid. A small number discussed the temperature being higher. Few candidates discussed either the rate or the success of the collisions as an explanation of the greater rate.

Exemplar 2

Experiment 1 has a greater rate of reaction because the particles are colliding more frequently therefore the number of successful collisions is increase. This is shown on the graph as the volume of carbon dioxide reaches 40 cm³ before the volume in experiment 2. This means that experiment 1 has a greater rate of reaction than experiment 2 where particles collide less often so there are less successful collisions. [6]

Both experiments produce 40 cm³ of carbon dioxide therefore only the rate of reaction is different as the time taken changes.

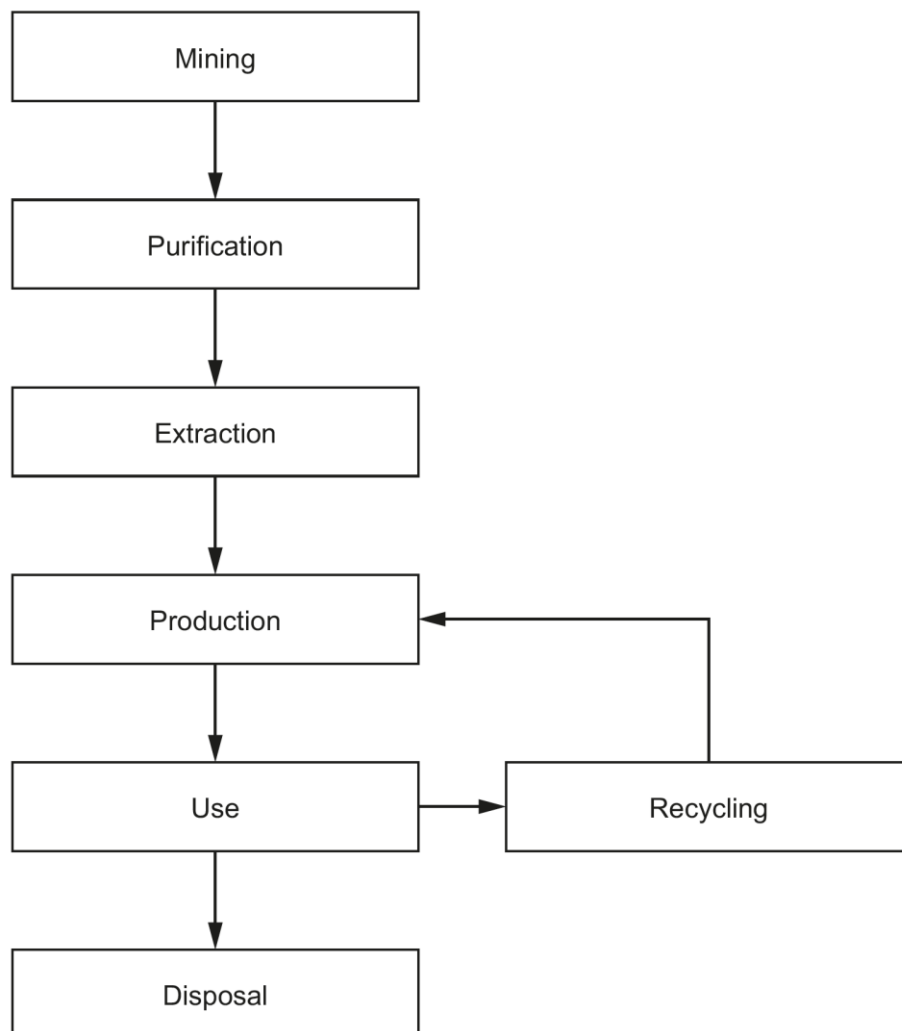
The candidate has chosen Experiment 1. The final volume of Experiment 1 being reached before that of Experiment 2 is a correct comment on the graph. The explanations for this difference are correct, higher rate of collisions and more successful collisions. This is Level 2, 4 marks.

There is no mention of the conditions which cause the rate to be higher which would be needed for the answer to be Level 3.

Question 16 (a)

16 Aluminium is extracted from a rock called bauxite which contains aluminium oxide.

The diagram shows information from a life-cycle assessment for the manufacture and use of aluminium products.



(a) Give **one** reason why a life-cycle assessment is carried out.

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

The reason for a life-cycle assessment proved very challenging for candidates. Many discussed it informing about the method of production of a product, the various uses of a product, the reasons for producing a product or referred to the life-cycle of a living organism. Creditworthy responses usually addressed waste, landfill or disposal. A significant number omitted the question.

Question 16 (b)

(b) Give **two** reasons why the products should be recycled at the end of their useful life.

- 1
-
- 2
-
- [2]

The majority of candidates described the process of recycling or repeated the question stem rather than explaining why products should be recycled. Creditworthy responses discussed less waste, less landfill or less global warming. A significant number omitted the question.

Question 16 (c)

(c) 18% of the bauxite rock is turned into aluminium.

Calculate the mass of aluminium that is extracted from 7500 kg of bauxite.

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

Mass of aluminium = kg [3]

Many candidates appreciated how to calculate a percentage. However, those that split up the percentage by calculating 10%, 5% and 1% and then adding them up often did so incorrectly by not having the separate percentages adding to 18%. Many divided 7500 by 18.

Many candidates gave their final answer as 1350 by omitting the need to give their answer to 2 significant figures. Of those that did attempt 2 significant figures 13 and 14 were quite common.

While some candidates just give a final answer, more candidates are showing their working and so error carried forward marks are able to be awarded.

A significant number omitted the question.

Exemplar 3

$$\begin{array}{l}
 10\% = 750 \\
 1\% = 75 \\
 8\% = 75 \times 8 = 600 \\
 750 + 600 = \underline{\underline{1350}} \\
 \underline{1350} = 136 \text{ (2 sig figures)}
 \end{array}$$

Mass of aluminium = 136 kg [3]

This is an example where the 18% has been splint into chunks which can then be added together to make 18%, 1350.

The candidate has then given the answer to what they consider to be 2 significant figures, which is incorrect.

This answer is given 2 marks.

Had the candidate not shown their working and just placed the answer 136 on the answer line they would have scored 0 marks.

OCR support



OCR's [Mathematical Skills Handbook](#) and accompanying [check in tasks](#) can be used with candidates to familiarise them with the mathematical skills in GCSE Science.

Question 16 (d)

(d) During the purification, aluminium oxide, Al_2O_3 , is produced from aluminium hydroxide, $Al(OH)_3$.

Complete the **balanced symbol** equation for the reaction.



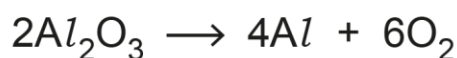
[2]

Some candidates had a 2 for the aluminium hydroxide but also a 2 for water. 2 and 1, 1 and 3, 6 and 6 and placing element symbols often H and Al were seen commonly. A significant number omitted the question.

Question 16 (e) (i)

(e) Aluminium is extracted from aluminium oxide, Al_2O_3 , by electrolysis.

(i) This is the equation for the electrolysis of aluminium oxide.



A student thinks that this reaction is an example of reduction.

Explain why the student is **correct**.

.....
 [1]

In this equation, $6O_2$ should have been written as $3O_2$. After analysing candidate performance during marking, we decided the fairest approach was to award all candidates full marks for this question.

Question 16 (e) (ii)

(ii) Extracting aluminium by electrolysis is expensive.

Which statements about why the electrolysis is expensive are **true**, and which are **false**?

Tick **one** (✓) box in each row.

	True	False
Aluminium oxide is melted at a high temperature.		
The electrolysis produces impure aluminium.		
The electrolysis uses large amounts of electricity.		

[2]

The reasons for the expense of electrolysis were well known. There was no apparent pattern to incorrect responses.

Question 16 (e) (iii)

(iii) It would be cheaper if aluminium could be extracted by heating the aluminium oxide with carbon.

Explain why aluminium oxide does **not** react with carbon.

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

The relative reactivity of aluminium and carbon proved very challenging, and many candidates omitted the question. Common incorrect responses included it is more reactive, it is not reactive, they are both non-metals and they are both gases.

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