



GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258 For first teaching in 201

J258/01 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 1 series overview

Candidates were comfortable with the time allocation and were able to work their way through to the end of the paper. However, candidates often seemed to lack confidence and, as last year, left blank spaces. There was the suspicion that some of those blank questions were because the context was unfamiliar, rather than the underlying concepts involved. Examiners never deduct marks, and even the least successful responses can sometimes demonstrate underlying understanding which is creditworthy. Candidates have nothing to lose!

Conversely, candidates who did well were more than willing to apply their scientific knowledge and understanding to unfamiliar looking situations.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
 took enough time to work out what the question was asking saw unfamiliar contexts as an opportunity to apply their scientific knowledge and understanding internalised information from graphs and charts, seeing them as more than sets of numbers but as giving information about the real world attempted questions even when uncertain of the answer showed their working for mathematical questions. 	 ignored part of what the question wanted left questions blank gave a response to mathematical questions but no working when working was shown, assumed that any division would entail dividing the large number by the small number regardless of what was actually needed.

Question 1 (a)

- 1 The increase in global population means there is a greater need for drinking water.
 - (a) What is the correct term for drinking water?

Tick (✓) one box.

Ground water	
Potable water	
Sea water	
Waste water	

[1]

This question was very well answered, with the vast majority of candidates choosing 'potable'. The main incorrect response was 'ground water'.

Question 1 (b)

(b) One source of drinking water is salt water.

Describe a process that separates water from salt water.

Unsurprisingly, the most obvious separation to come to candidates' minds is filtration, and so that was the majority answer given here. Even those who put down distillation often amplified it by describing it as a process that filtered the water.

Question 1 (c) (i)

- (c) Chlorine is added to drinking water.
 - (i) Why is chlorine added?

There was a very high level of understanding of the reasons for adding chlorine to water, and many candidates went beyond general statements about making it clean and safe to gain the mark for discussing the effect on microbes.

Question 1 (c) (ii)

(ii) Suggest one disadvantage of adding chlorine to drinking water.

......[1]

Successful responses showed evidence of thought and made reference to the toxic nature of chlorine, or even to its taste. Other candidates still appreciated that it might cause harm, though, not in enough detail to gain credit. It was interesting to see several responses which stated 'it's a chemical so it's dangerous'.

Question 1 (c) (iii)

(iii) Chlorine and other gases can be identified by simple tests.

Draw lines to connect each gas with its correct test.

	It gives a 'pop' with a lighted splint.
Chlorine	
	It relights a glowing splint.
Oxygen	
	It turns blue litmus paper red then bleaches it.
Carbon dioxide	
di a	It turns limewater milky.
	[3]

The tests for both chlorine and oxygen were well known. Surprisingly, it was carbon dioxide that caused problems, with a majority of candidates suggesting that it 'pops' with a lighted splint.

Exemplar 1



This response was surprisingly common.

Question 2 (a)

- 2 Alex tests some mineral water for calcium ions and chloride ions.
 - (a) The label on a bottle of mineral water states that 1000 cm³ of the mineral water contains 40.5 mg of calcium.

Calculate the mass of calcium in 500 cm³ of the mineral water.

1g = 1000 mg

Give your answer in grams.

Mass of calcium = g [3]

This calculation was very well attempted, and fortunately working was often shown so even incorrect responses often gained some credit. Probably the hardest part of the task lay in converting mg to g.

Question 2 (b)

(b) Alex heats 500 cm³ of the mineral water to make it more concentrated.

Draw a labelled diagram of the apparatus that Alex uses.

Examiners saw a far wider range of responses to this type of question than is normal. High scoring candidates were clearly familiar with basic chemical apparatus, though the vast majority of them spent considerable effort on drawing semi-perspectival images rather than rudimentary diagrams.

A large minority of candidates appeared to have minimal familiarity with basic equipment.

OCR support

PAG C5 indicates that candidates should be able to make and record appropriate observations during chemical reactions including changes in temperature. The <u>Practical support guide</u> has a variety of videos, activities and simulations that can be shared with candidates.

[1]

[2]

Question 2 (c)

(c) Alex tests for calcium ions by adding sodium hydroxide solution to the more concentrated mineral water.

Complete the word equation for the reaction.

CaCl ₂ (aq)	+	2NaOH(aq)	\rightarrow	Ca(OH) ₂ (s)	+	2NaCl(aq)
calcium chloride		sodium hydroxide				sodium chloride

Almost all candidates could state that the substance was calcium hydroxide.

Question 2 (d)

(d) Alex tests the more concentrated mineral water for chloride ions. A white precipitate is seen.

Complete the word equation for the test.

calcium chloride +	nitrate →	+ calcium
	white pr	ecipitate

While almost no candidates remembered that silver nitrate is the test for chloride ions, with most suggesting sodium nitrate, candidates were not penalised twice, so many gained a mark for correctly completing the word equation on that basis.

Question 2 (e)

(e) An industrial laboratory tests for calcium using emission spectroscopy.

Describe the advantages of emission spectroscopy compared with a flame test.

Many candidates gained credit for realising that emission spectroscopy would be quicker and more accurate. A significant minority were worried by the prospect of naked flames, and saw this as a major reason not to use flame tests.

Question 3 (a)

- 3 Steel is made from iron. Some products made from steel contain recycled iron.
 - (a) Complete the sentence to explain why recycling iron is better than making more iron from iron ore.

Use words from the list.

air	bacteria	energy	mining	transport

Recycling uses less and avoids use of

[2]

Reduced energy usage was widely recognised as a benefit of recycling, and most identified mining as the factor to be avoided. The most common other option was transport and candidates would benefit from understanding that transport is unavoidable when recycling materials.

Question 3 (b)

(b) One type of iron ore contains an oxide of iron, Fe₃O₄.

232g of Fe₃O₄ contain 168g of iron.

Calculate the percentage of iron, by mass, in Fe₃O₄.

Give your answer to 2 significant figures.

Percentage of iron = % [3]

High achieving candidates scored well here and, as in other calculations, other candidates who showed their working often gained credit despite having the wrong answer. Unfortunately, the less successful candidates tended to subtract the numbers rather than divide.

Assessment for learning



Examiners noticed the tendency to approach all mathematical calculations by subtracting any small number from a large number, or dividing any large number by the smaller number. Candidates could usefully be trained to recognise that questions involving ratios are unlikely to involve subtraction as a major stage.

OCR support

The <u>Mathematical Skills Handbook</u> provides both teachers and students support on the use of mathematical skills in GCSE sciences.

Question 3 (c)

(c) A problem with products made from iron is that they rust.

Which two statements about rusting are correct?

Tick (✓) two boxes.

Rusting can be prevented by using a physical barrier.

Rusting is a form of corrosion.

Rusting is a reduction reaction.

Rusting is caused by oxygen alone.

_	_	
	- 1	
	_	
	- 11	
	_	
-		
	- 1	
	_	
_	-	
	- 1	

[2]

That rusting can be prevented by using a physical barrier was well understood, with rusting being a reduction reaction being a very popular second choice.

Question 3 (d)

(d) Iron is a transition metal.

Which two statements about iron are correct?

Tick (✓) two boxes.

Iron forms coloured compounds.

Iron forms ions with more than one charge.

Iron has a low density.

Iron has a low melting point.

5				-
3	-	_	_	1
1	-	-	-	1
				T
2	-			1
		_	_	

[2]

Most candidates recognised that iron forms ions with more than one charge, though many forgot that it was iron they were discussing and suggested that it had low density for the second point.

Question 4 (a)

4 The reactivity series for some common elements is shown:

Cal	cium			
Alu	minium			
Ma	gnesium			
Car	bon	Less reactive		
Hyd	drogen			
Zin	c			
Iror	1			
(a)	Zinc can be extracted by Aluminium cannot be ex Explain why these states Use the reactivity series	y reacting zinc oxide with carbon. xtracted by reacting aluminium oxide with carbon. ments are correct.		

Almost all candidates referred to the reactivity series as instructed, and often went on to correctly discuss aluminium, carbon and zinc.

Question 4 (b) (i)

(b) The diagram shows how aluminium is made by the electrolysis of molten aluminium oxide.



(i) Which two statements about the electrolysis of aluminium oxide are correct?

Tick (✓) two boxes.

Al³⁺ ions move to the positive electrode.

Oxygen is also formed.

The aluminium oxide is molten so that the ions can move.

The negative electrode is made of steel.



[2]

Most candidates suggested that aluminium ions would move to the positive electrode. However, they did usually correctly recognise that the electrolyte is molten so that the ions can move.

Question 4 (b) (ii)

(ii) Complete the sentence to explain how the aluminium is formed.

Use words from the list.

[2]

While this was not seen as an easy question, many candidates did realise that the aluminium ions would gain electrons. The very common product suggested was, very understandably, 'ions'.

Question 4 (c) (i)

(c) (i) Why does the process of making aluminium by the electrolysis of molten aluminium oxide use a lot of energy?

......[1]

The fact that bauxite takes a lot of energy to melt was not realised by most candidates.

Question 4 (c) (ii)

(ii) A student states that aluminium can be extracted by the electrolysis of aluminium sulfate solution.

Explain why the student is wrong.

Use the reactivity series:	
Calcium	
Aluminium	
Magnesium	
Carbon	Less reactive
Hydrogen	
Zinc	
Iron	*
	[2]

While most candidates suggested that aluminium was too reactive to be extracted this way, almost noone realised that the water would take an active part and that hydrogen would be liberated.

Question 5 (a)

5 Table 5.1 shows information about some elements and oxides from Period 3.

Table 5.1

Name	Formula	Melting point	Does it conduct electricity when molten?	Does it conduct electricity when solid?	Structure
Magnesium oxide	MgO	high	yes		
Magnesium	Mg	high	yes		
Silicon dioxide	SiO ₂			no	giant covalent

(a) Complete Table 5.1.

[4]

Most candidates were able to score a mark from the first three columns, though a large minority suggested that magnesium would not conduct as a solid. Most candidates suggested that both structures were covalent, one being 'giant covalent' and the other being 'molecular covalent'. A few realised that magnesium had a metallic structure.

Many suggested silicon dioxide would have a low melting point, possibly because they did not read to the end of the row and missed the later information that it has a giant covalent structure.

Question 5 (b)

(b) Chlorine is a simple covalent molecule with a low melting point.

Which statements about chlorine and silicon dioxide are true, and which are false?

Tick (✓) one box in each row.

True	False
	True

[2]

Many candidates recognised that the bonds between silicon atoms and oxygen atoms were strong.

Question 5 (c)

(c) Both magnesium oxide and magnesium conduct electricity when molten.

Complete Table 5.2 to show the particles that conduct electricity.

Use words from the list.

atoms	electrons	ions	molecules
atoms	elections	10113	molecules

Table 5.2

	Particles that conduct electricity
Magnesium oxide	
Magnesium	

[2]

Electrons and ions were often identified by some candidates as the particles that conducted electricity. Unfortunately they were frequently used the wrong way round.

Question 6 (a)

- 6 Carbon dioxide and methane are both greenhouse gases.
 - (a) The statements describe the greenhouse effect.

Write the numbers 2, 3, 4 to show the correct order of the greenhouse effect.

One has already been done for you.

Greenhouse gases absorb infrared radiation.

Greenhouse gases emit infrared radiation in all directions.

The Earth emits infrared radiation.

Radiation from the Sun is absorbed by the Earth.



[1]

Responses suggested that candidates were familiar with the basics of the greenhouse effect; the question was very well answered.

Question 6 (b)

(b) Which statements about the greenhouse effect are true, and which are false?

Tick (✓) one box in each row.

144113.593

[3]

Almost half the candidates answered the whole of this question correctly, with the majority of the others scoring 1 or 2 marks. The most frequent incorrect response was that the Earth would be too hot without the greenhouse effect.

Question 7 (a)

- 7 Two polluting gases produced by petrol engines are carbon monoxide, CO, and nitrogen monoxide, NO.
 - (a) Describe how nitrogen oxide is produced in a petrol engine.

......[2]

Almost all candidates stated or assumed that the nitrogen comes from the petrol, and the only component of the air to react is the oxygen.

Assessment for learning – teaching point

The nitrogen in the air is normally an unreactive gas, but at the high temperatures inside a car engine it will react with oxygen.

Question 7 (b) (i)

(b) Nitrogen monoxide and carbon monoxide react together in a catalytic converter.

The equation for the reaction that happens is

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

(i) State the product formed by oxidation.

Explain your answer.

A large majority of candidates gave both products for the reaction rather than just the product of oxidation.

Assessment for learning

Don't assume the question says what you think it does!

Question 7 (b) (ii)

(ii) Riley says that the catalytic converter removes all gases which can harm the environment.

Explain why Riley is wrong.

 Many candidates gained a mark for realising that the catalytic converter is not 100% efficient. However, the question did expose considerable confusion over what a catalytic converter does, with candidates often suggesting that if it removed all gases from the atmosphere there'd be nothing left to breathe.

Despite having assumed the nitrogen came from the petrol in the earlier part, many candidates now remembered that it was a component of the atmosphere, though were not able to connect their various strands of knowledge, so unfortunately it was often suggested that nitrogen gas harms the environment.

Question 7 (c) (i)

(c) The bar chart shows the relative amounts of the two polluting gases produced by a petrol engine without and with a catalytic converter.



Some candidates internalised and made sense of the information in the bar chart and went on to express articulate conclusions and so scored well.

Others interacted with the information and gained some credit for detailed comparisons of amounts, even when it was clear that their understanding was incomplete. Candidates frequently suggested the chart shows that CO is more polluting than NO, or that the CO *produces* more gas than NO.

Frequently candidates made a valid point, but then went on to say the same thing the opposite way round.

Exemplar 2

produced without a catalytic More 993 is CUAV Carbon MONO 15 produced 2 ther efters rcal DN

The candidate makes two valid points, but then repeats the first point the other way round.

Question 7 (c) (ii)

(ii) Calculate the value of the ratio:

CO produced by a car without a catalytic converter NO produced by a car without a catalytic converter

Ratio = _____ [2]

.....

Very well answered, with the most common mistake being to quote the figures with a catalytic converter.

Question 7 (d)

(d) Molecules of another oxide of nitrogen contain two nitrogen atoms and one oxygen atom. Write the formula of this oxide of nitrogen.

.....[1]

Some candidates clearly understood the nature of the problem and gave sensible responses. Other candidates appeared to misunderstand this question and tried to give an equation for the reaction. Examiners would have still given credit if the final formula had been correct.

Question 8 (a)

8 The Contact Process is used to produce sulfuric acid.

In the process, sulfur dioxide, SO2, reacts with oxygen to make sulfur trioxide, SO3:

.....+......

(a) Complete the balanced symbol equation for this reaction.

[2]

Many candidates made a good attempt at the equation, but unfortunately used O instead of O_2 . The most successful candidates recognised the need for O_2 and subsequently balanced the equation correctly.

Question 8 (b)

(b) The symbol ⇒ indicates that the reaction is reversible and can reach equilibrium.

Which two statements are correct when the reaction reaches equilibrium?

Tick (✓) two boxes.

Rate of forward reaction = rate of reverse reaction The reaction stops when equilibrium is reached. The reaction stops when there is 100% SO₃. There will always be some SO₂ left at equilibrium.

[2]

Most candidates knew that the rate of the two reactions would be the same, but the large majority went on to choose an answer that said the reaction would stop, usually when equilibrium was reached.

Question 8 (c) (i)

(c) The graph shows the percentage of SO₂ converted to SO₃, at different temperatures.



Describe the general trend of the graph.

[1]

This question was very well answered, with candidates either suggesting that as temperature increased, percentage converted decreased, or alternatively saying that there was a negative correlation. Many candidates were confused over which was the independent variable, but were not penalised for this.

Exemplar 3

decreasos de Describe the general trend of the graph. onventer! o ch

The candidate has not appreciated that temperature is the independent variable, not percentage conversion, but that confusion was ignored by examiners.

Question 8 (c) (ii)

(ii) Use the graph to estimate the percentage of SO₂ converted to SO₃ at 400 °C.

Percentage of SO₂ converted to SO₃ = % [1]

Almost all candidates made an excellent job of estimating the percentage from their graph.

Question 8 (c) (iii)

(iii) Use the graph to estimate the percentage of SO₂ remaining at 800 °C.

Percentage of SO₂ remaining =% [2]

Most candidates gained credit for correctly working out the percentage of SO₂ converted at 800°C, though did not perform the last stage and calculate the percentage of SO₂ remaining.

Question 8 (c) (iv)

(iv) Calculate the percentage of SO₂ converted to SO₃ when 20 g of SO₃ is made from 32 g of SO₂.

Use the equation:

mass of SO₂ × percentage of SO₂ converted to SO₃ = mass of SO₃ × 80

Percentage of SO₂ converted to SO₃ = % [3]

The most successful candidates rearranged the equation and correctly calculated the percentage. The main error for those who went wrong was to divide 32 by 20 rather than the other way round.

Assessment for learning

Calculations don't always mean dividing the big number by the little number.

Question 9 (a)

9 Argon forms 1% of the air and is unreactive.

Argon is used as a replacement for nitrogen when nitrogen is too reactive.

(a) Argon is unreactive because it is in Group 0 of the Periodic Table.

State one other property of argon.

......[1]

Questions 9 and 10 were common to the higher tier paper.

While there were many sensible responses, there was some confusion as to what the term 'property' meant, and some candidates tried to described electron configuration.

Question 9 (b)

(b) Chlorine is very reactive. Argon is unreactive.

Explain how the reactivity of these two elements are related to the arrangement of electrons in their atoms.

The highest achieving candidates were able to say that argon has a full outer shell so was unreactive, and the most successful correctly went on to state that chlorine has seven electrons so tries to gain one more.

Question 9 (c) (i)

- (c) An element X has two electron shells with one electron in its outer shell.
 - (i) Which statements about X are true, and which are false?

Tick (✓) one box in each row.

True	False
	True

Despite doing well in the previous part, candidates found this question more challenging.

Question 9 (c) (ii)

(ii) Name one element that is more reactive than element X.

Many candidates quoted francium as a very sensible response. Others suggested chlorine.

Question 9 (d)

(d) An argon atom has a mass number of 40.

Calculate the number of neutrons in its nucleus.

Use the Periodic Table.

Number of neutrons =[1]

Some candidates did quite well here, while others usually suggested 20.

Question 10 (a) (i)

- 10 Formic acid is used to remove limescale from kettles.
 - (a) Formic acid is a carboxylic acid with the formula HCOOH.
 - (i) Draw the displayed formula of formic acid.

Show all the bonds.

Very few candidates attempted this question.

Question 10 (a) (ii)

(ii) The name of the carboxylic acid with the formula CH₃COOH is ethanoic acid.

What is the name of formic acid?

Tick (✓) one box.

Butanoic acid

Methanoic acid

Propanoic acid

This was not successfully answered, despite the fact that some candidates had written down 'methane, ethane, propane, butane' at the start of the paper as a clear reminder to themselves.

Question 10 (b)

(b) Ling and Taylor dip a piece of universal indicator paper into a solution of formic acid.

What pH value could the solution of formic acid be?

.....[1]

The question discriminated well, with some candidates giving suitable values. Examiners did accept numbers down to zero as this question was not about acid strength.

Question 10 (c) (i)

(c) Limescale contains calcium carbonate.

A solution of formic acid fizzes when it reacts with calcium carbonate.

(i) Name the gas that causes the fizzing.

......[1]

This was surprisingly problematic, with many candidates getting confused.

Question 10 (c) (ii)

 (ii) A salt called calcium formate is also formed when formic acid reacts with calcium carbonate.

The formula of the calcium ion is Ca²⁺. The formula of the formate ion is HCOO⁻.

Write the formula of calcium formate.

......[1]

As with the displayed formula, very, very few could write the formula. The main problem appeared to be how to show that two formate anions would be needed for each calcium. Almost no candidates put the anion into brackets.

Question 10 (d) and 10 (e) (i)

(d) Calcium carbonate is insoluble in water. Calcium formate is soluble in water.

Sam wants to make some calcium formate crystals.

This is the method:

- · stir calcium carbonate with a solution of formic acid
- · stop adding calcium carbonate when no more reacts
- leave the mixture to crystallise.

An extra step is needed to make pure calcium formate crystals.

Name the extra step and explain why it is needed.

(e) (i) Umi and Zayn have a dilute solution of calcium formate.

They want to make dry crystals of calcium formate.

Name one separation technique they must use.

.....[1]

As in Question 2, very few candidates showed familiarity with laboratory practice.

Question 10 (e) (ii)

(ii) They use 20.0 g of calcium carbonate and get 7.8 g of pure calcium formate.

Chemists calculate that 10.0 g of calcium carbonate should make 13.0 g of calcium formate.

Calculate the percentage yield of calcium formate.

Use the formula: percentage yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$

Percentage yield of calcium formate = % [3]

This was answered more successfully, and while many candidates missed the instruction to calculate for 10g and not 20, they frequently picked up 2 marks for showing suitable working.

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Please get in touch if you want to discuss the accessibility of resources we offer to support you in delivering our qualifications.