

Examiners' report

GCSE

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

**OCR Level 1/Level 2 GCSE (9-1) in
Chemistry B (Twenty First Century
Science)**

J258

For first teaching in 2016

J258/02 Summer 2025 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 responses 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 [Teach Cambridge](#).

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Paper 2 series overview

This paper is designed to assess the depth of chemical knowledge shown by the candidates. Most candidates were able to attempt most questions, even if they did not always manage to earn many marks. To do well, candidates needed to make use of the information they had been given but also to bring their own knowledge of chemistry into play. The exam included mathematical assessment which was often done quite well. The extended prose required in some questions (Question 3 (b) (ii) and Question 7 (b)) was a challenge for some candidates. These questions provide a structure which the most successful candidates use to good effect.

Some candidates show disappointing lack of practical experience. Questions 8 and 9 were an overlap with the Higher tier paper so provided some of the most demanding challenges.

To achieve well, candidates needed to take care to read the questions as there is often key information in the stem. Some candidates also did not gain marks by misreading the question or answering a question of their own devising. The language of the examination was inclusive and there was no evidence that any candidates were disadvantaged.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
- used the question stem to structure a complete answer (Question 3 (b) (ii)) - interpreted graphical data successfully (Question 2 (c) (i) and Question 5) - integrated their knowledge with the information in the question (Question 4).	- did not attempt all the questions - did not demonstrate familiarity with laboratory apparatus (Question 7 (b) and Question 9) - were not confident in handling very large numbers (Question 5 (b) and Question 5 (c)) - described something that should have been <i>explained</i>.

Question 1 (a) (i)

1 Fig. 1.1 shows the names and formulae of some acids and alkalis.

Fig. 1.1

	Name of compound	Formula
Acids	Hydrochloric acid	HCl
	Sulfuric acid	H ₂ SO ₄
Alkalis	Lithium hydroxide	LiOH
	Sodium hydroxide	NaOH
	Potassium hydroxide	KOH

(a) Write down the name of a compound from Fig. 1.1 to answer the following questions.

(i) Which compound has a formula with 2 atoms?

..... [1]

Sulfuric acid was the most common response, indicating that many candidates did not understand formulae.

Question 1 (a) (ii)

(ii) Which **alkali** reacts with hydrochloric acid to make sodium chloride?

..... [1]

Most candidates understood the need for some sodium in the answer.

Question 1 (a) (iii)

(iii) Which **alkali** has the highest relative formula mass?

Use the Periodic Table to help you.

..... [1]

This was well answered, although some candidates calculated the formula mass for all five compounds.

Question 1 (a) (iv)

(iv) Which **two** compounds can each react with magnesium metal to make hydrogen?

..... and [1]

Few candidates recognised this as a property of acids.

Question 1 (a) (v)

(v) Which compound gives a white precipitate when a few drops are added to dilute barium nitrate?

..... [1]

This test for sulfate ions was not well known.

Question 1 (b)

(b) Which statements are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
Acids form hydrogen ions when they dissolve in water.		
All neutralisation reactions make water.		
Copper does not react with dilute acid.		
Titration gives qualitative data.		

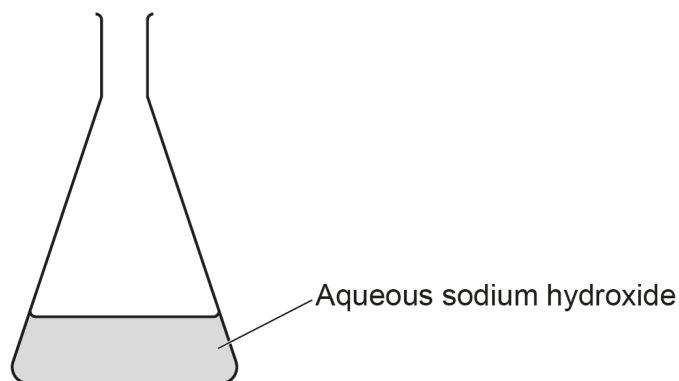
[3]

Many candidates were not confident about characteristics of acids during neutralisation.

Question 1 (c) (i)

- (c) A student does a titration to find out how much acid is needed to neutralise 25.0 cm^3 aqueous sodium hydroxide.

They add the aqueous sodium hydroxide to a conical flask.



- (i) The student adds another substance to the conical flask so that they know when the aqueous sodium hydroxide is neutralised.

Name this substance.

Describe how the substance shows the student that the aqueous sodium hydroxide has been neutralised.

Name

Description

.....

[2]

Most candidates were aware that neutralisation was shown by a colour change. However, universal indicator cannot show a clear end-point. Candidates should be made aware of indicators which are more suitable for titration.

Misconception

Most candidates were aware that neutralisation was shown by a colour change, but many specified universal indicator which cannot show a clear end-point.

OCR support

A number of the GCSE Examiner Reports this year have raised the concern that candidates' practical skills and knowledge is in decline. OCR has produced a wealth of practical resources to support teachers as. Find them on [Teach Cambridge](#) now.

Question 1 (c) (ii)

(ii) Which other piece of apparatus does the student need to do the titration?

Tick (✓) **one** box.

Bunsen burner

☐

Burette

☐

Stop clock

☐

Test-tube

☐

Thermometer

☐

[1]

Almost half of the candidates knew that a burette would be used in titration.

Question 1 (c) (iii)

(iii) The student does the titration and then looks at the results of another student.

Explain why the student looks at the results of another student.

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

The idea of checking for consistency of answers was commonly given.

Question 2 (a)

2 Several processes can be used to produce drinking water.

Each process has a purpose.

(a) Draw lines to connect each **water treatment process** with its correct **purpose**.

Water treatment process

Aeration

Distillation

Filtration

Purpose

Separates pure water from salt water.

Uses oxygen to break down harmful waste.

Removes solid impurities.

[2]

The purpose of the three water treatments was commonly understood.

Question 2 (b)

(b) Water for drinking is treated with chlorine.

What is the **test** and **expected result** for chlorine gas?

Tick (✓) **one** box in each column.

Test

Aqueous bromine

☐

Damp blue litmus paper

☐

Lighted splint

☐

Expected result

goes blue

☐

goes green

☐

goes red then white

☐

[2]

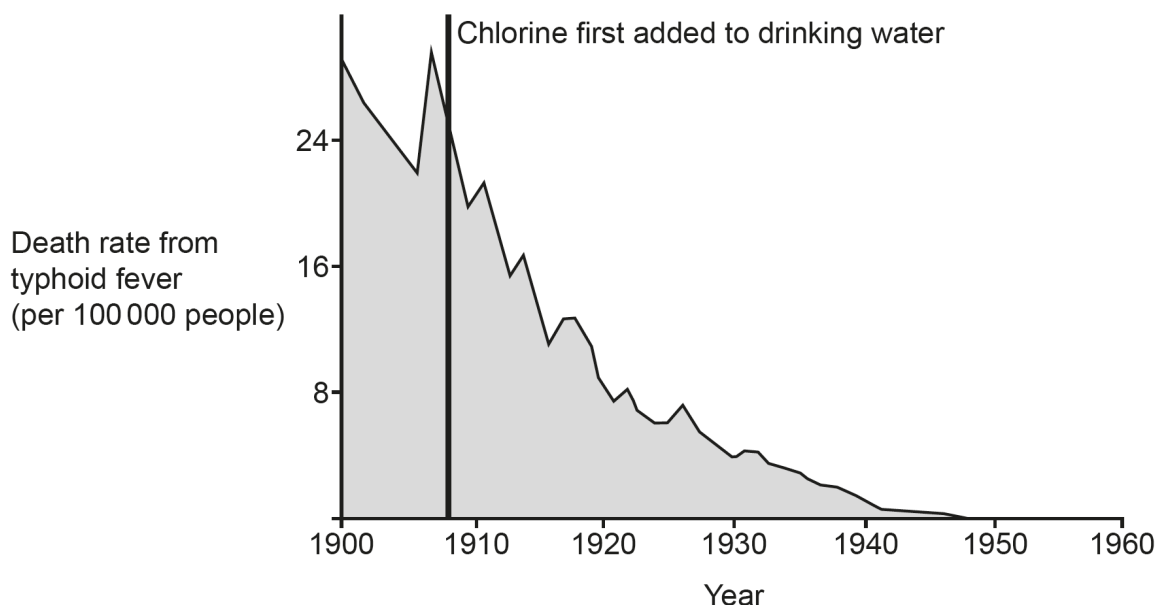
The bleaching effect of chlorine was rarely specified.

Question 2 (c) (i)

- (c) Typhoid fever is a disease that causes death. It is caused by harmful microorganisms in water.

Chlorine was first added to drinking water in the United States in 1908.

The graph shows the death rate from typhoid fever in the United States before and after chlorine was first added to drinking water.



- (i) Describe what the graph shows about the death rate from typhoid fever in the United States before and after chlorine was first added to drinking water.

.....

.....

.....

..... [2]

Candidates usually reported that the death rate had decreased after chlorine was added to the water. Many noted that the rate had been very high before the addition – but the mark scheme also allowed descriptions of other features to achieve the second mark.

Question 2 (c) (ii)

(ii) A student looks at the graph and has this idea:

'The graph shows that everyone in the world has had water that is safe to drink since about 1948.'

Suggest **two** reasons why the student is **not** correct.

1

.....

2

.....

[2]

Candidates usually realised that data about the USA might not reflect the entire world. The idea that other risks might not be resolved by the addition of chlorine was less commonly understood.

Question 2 (d)

(d) The effect of adding chlorine to drinking water was an important scientific discovery.

Today, information about important scientific discoveries is published for peer review.

Explain what happens during peer review.

.....

.....

.....

..... [2]

Candidates often used the context of their own lab-work rather than 'scientific discoveries'. Unsuccessful answers tended to re-use the word 'review,' failing to explain what this means.

Question 3 (a)

3 Pure iron corrodes easily and is **not** strong enough for some uses.

(a) When iron corrodes it reacts with oxygen to make iron(III) oxide.

Complete **Table 3.1** by filling in the missing formulae and state symbols.

Table 3.1

	Formula	State symbol
Iron		(s)
Oxygen		
Iron(III) oxide	Fe_2O_3	

[3]

The state symbols were less well understood than the formulae.

Question 3 (b) (i)

(b) Steel is a mixture of iron with other elements.

Table 3.2 shows the percentages of other metals mixed with iron in two types of steel.

Table 3.2

Type of steel	Percentage of other elements mixed with iron
Steel 1	chromium 16.7% nickel 8.1% copper 3.6% carbon 0.1%
Steel 2	carbon 1.9%

(i) Calculate the percentage of iron in **Steel 1**.

Percentage of iron = %
[2]

This calculation was usually completed successfully.

Question 3 (b) (ii)*

(ii)* Adding different elements to steel changes its properties.

Table 3.3 shows the effect on properties of steel of adding different elements.

Table 3.3

Element	Effect on properties of steel
Chromium	More corrosion resistance, especially at high temperatures.
Nickel	More corrosion resistance. Can be bent more without breaking.
Carbon	Increasing amounts increases hardness but also makes steel more easy to break. No effect on corrosion resistance.
Copper	Electrical conductivity increases. More corrosion resistance in sea water.

Steel 1 is used to make engine parts for ships.

Predict the properties of **Steel 1** and **Steel 2** and explain why **Steel 1** is suitable to make engine parts for ships but **Steel 2** is **not**.

Use the information in **Table 3.2** and **Table 3.3** in your answer.

.....

.....

.....

.....

.....

..... **[6]**

Exemplar 1

While steel 1 already has a variety of elements mixed with iron already in it, steel 2 only contains 1.9% of carbon mixed with iron. I think that steel one is already quite malleable whereas steel two isn't and steel one is overall stronger than steel two. ~~prior~~ steel one includes all the properties of each element within it (e.g. more corrosion resistance, electrical conductivity increases) ~~and from the~~ ~~sep~~ steel one is especially suitable to make engine parts for ships as it contains copper which increases its corrosion resistance in sea water, and steel two doesn't have this property at all. Steel two contains 1.9% of carbon which makes it easier to break.

A Level 3 answer (6 marks) reviewed the properties of both types of steel – and identified the properties which made Steel 1 suitable for marine engine components and those which made Steel 2 unsuitable.

Misconception

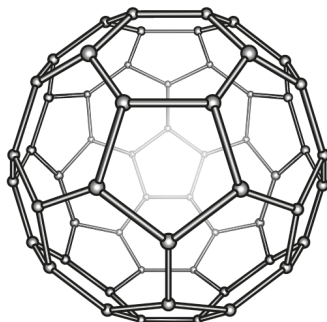


The properties of an alloy are related to the elements used, but the alloy does not show all the properties of the individual metals involved.

Question 4 (a)

4 Carbon nanoparticles contain only carbon atoms.

Buckyballs are a type of carbon nanoparticle that have carbon atoms joined together in a ball with a hollow centre.



(a) Which statements about buckyballs and other nanoparticles are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
Buckyballs are chemical compounds.		
Buckyballs are larger than carbon atoms.		
Diamond and graphite are examples of nanoparticles.		
Some nanoparticles are shaped as tubes.		

[3]

Nanoparticles have become a familiar part of mainstream knowledge. Most candidates achieved at least one mark here.

Question 4 (b)

(b) The surface area to volume ratio of a buckyball can be calculated using this formula:

$$\text{surface area to volume ratio} = \frac{3}{r} \quad \text{where } r \text{ is the radius of the buckyball in nm.}$$

Calculate the surface area to volume ratio of a buckyball that has a radius of 0.5 nm.

Surface area to volume ratio = [2]

Although the calculation is not intuitive, it was usually done well. A few candidates insisted on inventing units for the ratio.

Question 4 (c)

(c) Scientists are developing ways of using nanoparticles to carry medicines into the human body.

Some people think that using nanoparticles to carry medicines may cause risks.

Which **two** statements explain why using nanoparticles may cause risks?

Tick (✓) **two** boxes.

Medicines can be carried in the hollow spaces in nanoparticles.

Nanoparticles are small enough to enter the brain.

Nanoparticles have a high surface area.

There is more data about uses of nanoparticles than about their effects on health.

☐
☐
☐
☐

[2]

The risks and benefits of the use of nanoparticles have become well known, so very few candidates did not score here.

Question 5 (a)

5 Both natural fertilisers and synthetic fertilisers are used to grow food crops.

The graph shows data between 1900 and 2020 for:

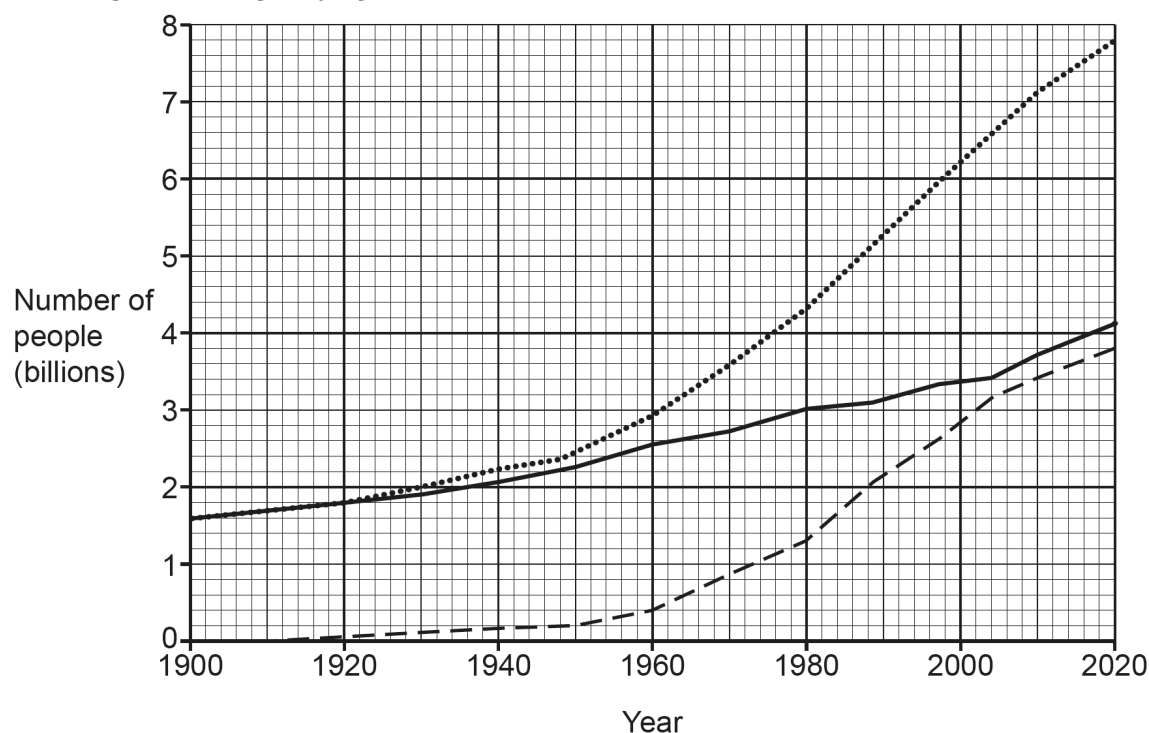
- the world population
- the number of people that could be fed from food grown using only **natural** fertilisers
- the number of people that could be fed from food grown using only **synthetic** fertilisers.

Key

..... World population

———— Number of people that could be fed from food grown using only **natural** fertilisers

- - - Number of people that could be fed from food grown using only **synthetic** fertilisers



(a) Predict when the first **synthetic** fertiliser became available.

Use the graph.

..... [1]

A range of answers were accepted, but a tiny number of candidates did not appreciate how the graph related to the question and gave dates which were well after the start of the relevant line.

Question 5 (b) (i)

(b)

- (i) How many people could be fed with food grown using only **natural** fertilisers in 1900 and 2020.

Use the graph.

Number of people that could be fed using only **natural** fertilisers in 1900

Number of people that could be fed using only **natural** fertilisers in 2020

[2]

Most candidates read numbers from the graph, although some missed the use of the word 'billions' in the scale (or added many zeros).

Question 5 (b) (ii)

- (ii) Calculate the percentage increase in the number of people that can be fed using only **natural** fertilisers between 1900 and 2020.

Give your answer to 1 decimal place.

Percentage increase = % [3]

Although candidates often recognised that increase was the difference between the two numbers in the previous question, expressing this as a percentage was not well understood – and the need to answer with one decimal place was frequently missed.

Question 5 (c)

(c) A student looks at the graph and has this idea:

'The total amount of food that can be grown using both natural and synthetic fertilisers in 2020 is enough to feed everybody in the world.'

Is the student correct?

Use data from the graph to explain your answer.

.....

.....

.....

..... [2]

Good responses here identified the world population in 2020 from the graph and compared this to the sum of the two fertiliser figures. A few candidates ignored the data in the graph and answered using current estimates of the world population.

Question 5 (d)

(d) Making and using synthetic fertilisers has both costs and benefits.

Which statements about making and using synthetic fertilisers are a **benefit** and which are a **cost**?

Tick (✓) **one** box in each row.

	Benefit	Cost
Synthetic fertilisers are used to increase the rate of growth of food crops.		
The manufacture of synthetic fertilisers uses energy from fossil fuels.		
Using synthetic fertilisers causes eutrophication.		

[2]

Costs and benefits were generally well understood so very few candidates did not score here.

Question 5 (e)

(e) Most synthetic fertilisers contain three essential elements.

One essential element is nitrogen.

Which **two other** essential elements do fertilisers contain?

Tick (✓) **two** boxes.

Carbon

☐

Hydrogen

☐

Oxygen

☐

Phosphorus

☐

Potassium

☐

[2]

Synthetic fertilisers generally replenish the amounts of phosphorus and potassium along with soluble nitrogen in the soil. The other elements are provided during photosynthesis

Misconception

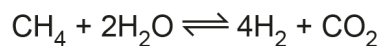


Perhaps recognising the importance of photosynthesis, many candidates chose carbon and oxygen as the essential elements in synthetic fertilisers instead of phosphorus and potassium.

Question 6 (a)

6 Hydrogen is made when methane reacts with steam.

The equation shows the reaction.



(a) Which **two** statements explain why this reaction does **not** give a 100% yield?

Tick (✓) **two** boxes.

At the end of the reaction there will be some unreacted methane.

☐

Carbon dioxide cannot be used as a fuel.

☐

Carbon dioxide is a waste product.

☐

The equation has a reversible symbol.

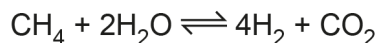
☐

[2]

The idea that a reversible reaction would have an incomplete yield was usually understood.

Question 6 (b) (i)

(b) The table shows information about the masses of some of the substances in the equation.



	Relative formula mass	Total mass in equation
CH ₄	16	16
H ₂ O	18	2 × 18 = 36
H ₂	2	4 × 2 = 8

(i) Explain why the total mass of hydrogen in the equation is given by $4 \times 2 = 8$.

.....

.....

.....

..... [2]

Candidates found it difficult to explain where the numbers 2 and 4 originated.

Exemplar 2

In the equation it shows that 4 amounts of H₂ is given. H₂ has a Relative formula mass of 2 as there is 2 atoms of Hydrogen (diatomic) and Hydrogen has a mass of 1 and there is 4 lots meaning you times 4 by 2 giving 8. [2]

This response explains both the use of "2" (relative mass) and "4" (number of molecules) so achieving full marks.

Question 6 (b) (ii)

(ii) Calculate the atom economy of the reaction.

Use:

- data from the table above
- the formula: $\text{atom economy} = \frac{\text{total mass of hydrogen in equation}}{\text{total mass of all reactants in equation}} \times 100$

Atom economy =%
[2]

Most candidates correctly used '8' as the mass of hydrogen in the equation, but then added together all the masses given in the table instead of using just the reactants.

Misconception



Candidates were given the total mass of hydrogen in the table, but included all three species in the table instead of just the two substances reacting.

Question 6 (b) (iii)

(iii) Calculate the relative formula mass of carbon dioxide, CO₂.

Use the Periodic Table.

Relative formula mass = [2]

Many candidates identified the masses of carbon and oxygen from the Periodic Table – high attaining candidates commonly gave the final answer correctly.

Question 6 (c) (i)

(c) The carbon dioxide is separated from the hydrogen and used in another process to make methanol (CH_3OH) to be used as a fuel.

(i) Which **two** statements give benefits of using the carbon dioxide in another process?

Tick (✓) **two** boxes.

Hydrogen and carbon dioxide are easy to separate.

☐

Less energy needs to be used to make hydrogen.

☐

The carbon dioxide is a by-product and **not** a waste product.

☐

The carbon dioxide is **not** released into the air.

☐

[2]

The benefits of using a waste product in another process were not well understood.

Question 6 (c) (ii)

(ii) When hydrogen and methanol (CH_3OH) are burned as fuels they form products.

Draw lines to connect each **fuel burned** to the correct **products**.

Fuel burned

Hydrogen

Methanol
(CH_3OH)

Products

Only water

Only carbon dioxide

Carbon dioxide and water

[2]

Candidates who performed well overall were most likely to gain both marks here.

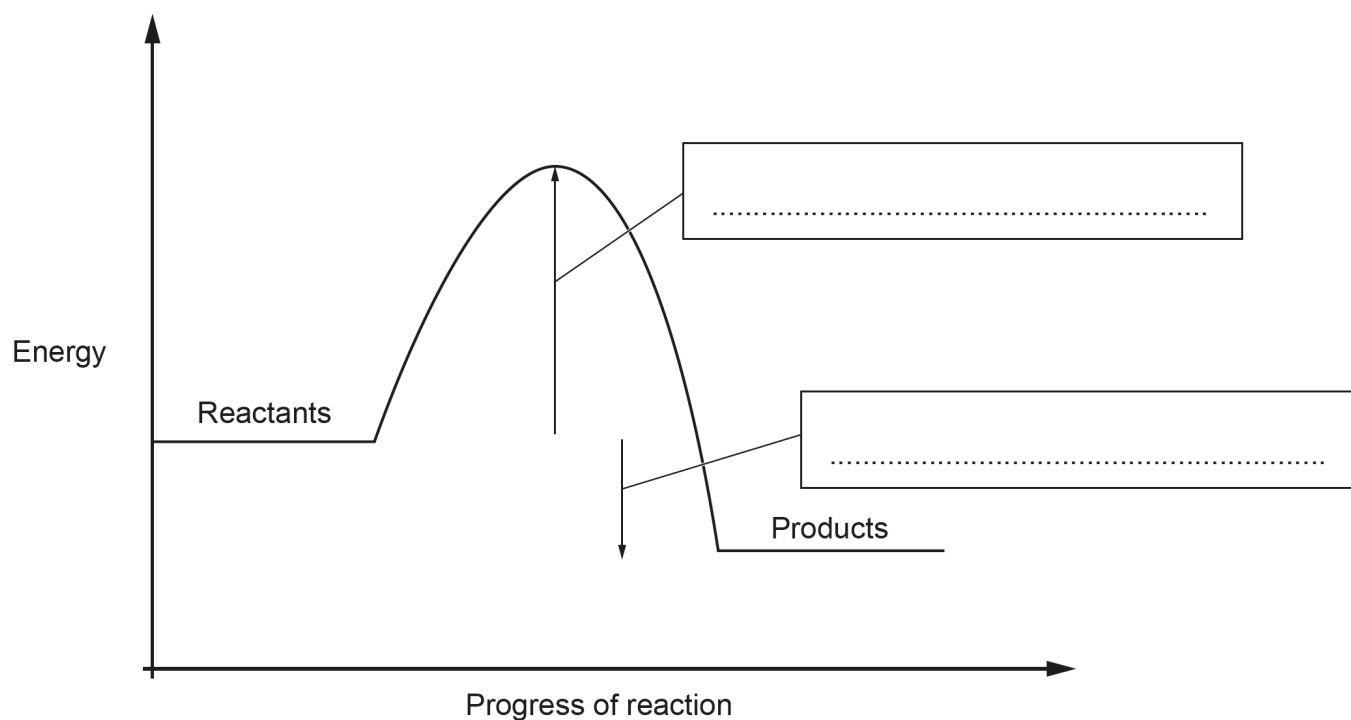
Question 7 (a)

7

(a) Fig. 7.1 shows a reaction profile diagram for a reaction.

Complete Fig. 7.1 by filling in the labels.

Fig. 7.1



[2]

The reaction profile was not well understood. Some candidates named the activation energy, but the overall enthalpy change for the reaction was rarely recognised. The words exothermic and endothermic do not adequately describe the amounts of energy shown in the diagram

Question 7 (b)*

(b)* Fig. 7.2 shows the trend in energy changes when some compounds dissolve in water.

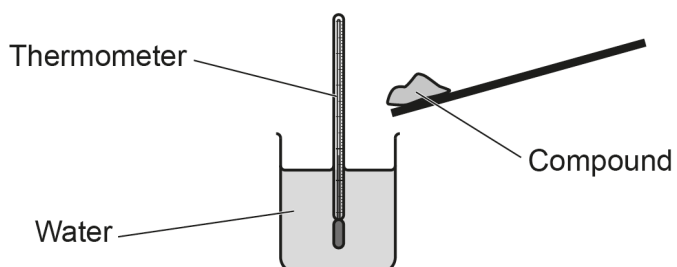
Fig. 7.2

Compound	Trend
Potassium chloride	Energy change becomes more endothermic when compound dissolves in water.
Potassium bromide	
Potassium iodide	

A student wants to show that the trend in **Fig. 7.2** is correct.

Fig. 7.3 shows the apparatus they set up.

Fig. 7.3



Describe how the student can use samples of the compounds in **Fig. 7.2** and the apparatus shown in **Fig. 7.3** to show that the trend in **Fig. 7.2** is **correct**.

Include in your answer:

- their method
- what they need to keep constant
- the results expected if the trend in energy changes shown in **Fig. 7.2** is correct.

[6]

This question showed up a lack of laboratory experience for many candidates and many simply did not attempt it. The practical details (including control of variables) were often poorly described. Few candidates knew what to expect from an endothermic change and fewer still could safely describe a trend in results.

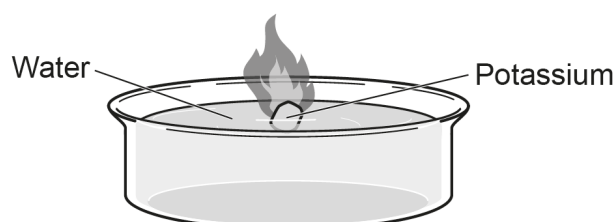
Question 8 (a)

8 Potassium, sodium and lithium are metals in Group 1 of the Periodic Table.

A student watches a video of the reaction of potassium with water.

Fig. 8.1 shows a diagram of the experiment.

Fig. 8.1



The table shows information about this reaction.

Metal	Products of the reaction	Observations
Potassium	Potassium hydroxide Hydrogen gas	Potassium moves quickly on the surface of the water and fizzes violently. Potassium burns with a pale purple flame.

(a) The student then watches a video of the reaction of **sodium** with water.

Predict the products of the reaction of sodium with water and describe the observations you expect.

Products and

Observations

.....

.....

.....

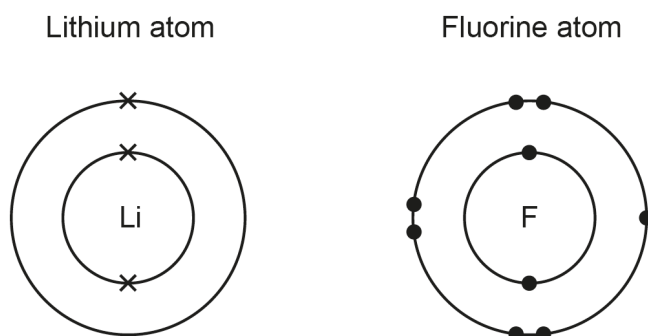
[3]

Some candidates missed the mention of sodium in the question, instead repeating observations for potassium from the table. Those who did consider sodium often knew that the reaction would be less vigorous, but were unsure of a flame colour.

Question 8 (b) (i)

(b) Fig. 8.2 shows the arrangement of electrons in a lithium atom and a fluorine atom.

Fig. 8.2



(i) Lithium and fluorine belong to different groups of the Periodic Table.

Explain how the arrangement of electrons in lithium and fluorine is related to their **groups** in the Periodic Table.

.....

.....

.....

..... [2]

Question 8 (b) (ii)

(ii) Explain how Fig. 8.2 shows that lithium and fluorine are in the same **period** of the Periodic Table.

.....

..... [1]

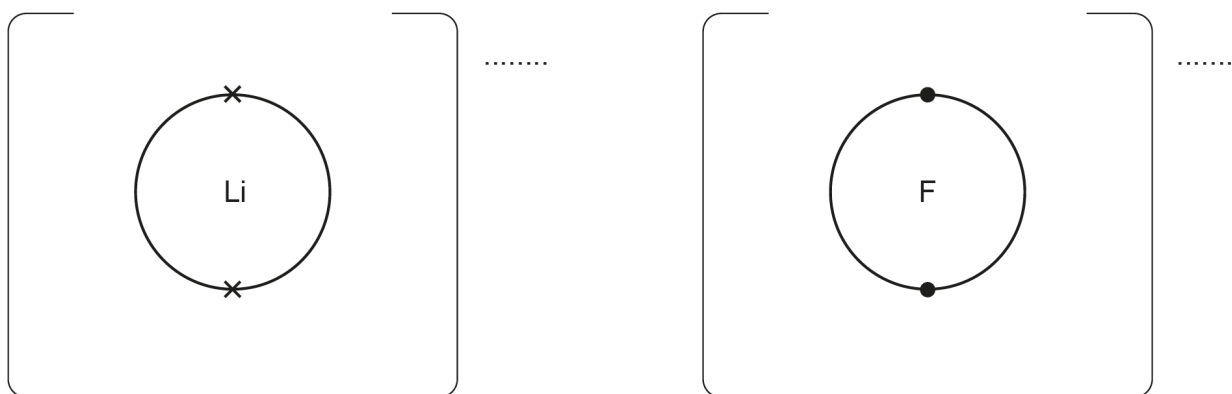
The relationship between electronic structure and the position in the Periodic Table was sometimes explained perfectly – but a number of candidates did not attempt either Question 8 (b) (i) or Question 8 (b) (ii).

Question 8 (b) (iii)

(iii) Lithium fluoride is an ionic compound that has lithium ions and fluoride ions.

Fig. 8.3 shows a dot and cross diagram of these ions.
The diagram is **not** complete.

Fig. 8.3



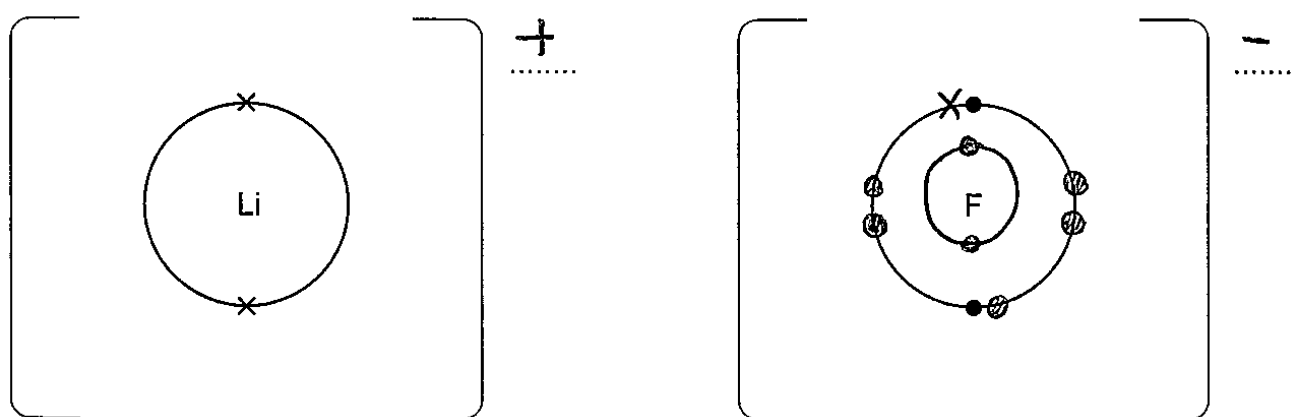
Complete **Fig. 8.3**.

You need to:

- show the arrangement of electrons in the **fluoride** ion
- show the charges on **both** ions.

[3]

Exemplar 3



Charges on the ions were sometimes correct. A few excellent answers showed not only the second shell on the fluoride ion, but also seven dots and one cross to indicate the source of the electrons.

Question 8 (b) (iv)

(iv) Which statement gives a correct limitation of using a complete dot and cross diagram to represent ionic bonding?

Tick (✓) **one** box.

It does **not** show that the ions are different sizes.

It does **not** show the correct ratio of numbers of ions.

It does **not** show the total number of electrons.

It only shows shared electrons.

☐
☐
☐
☐

[1]

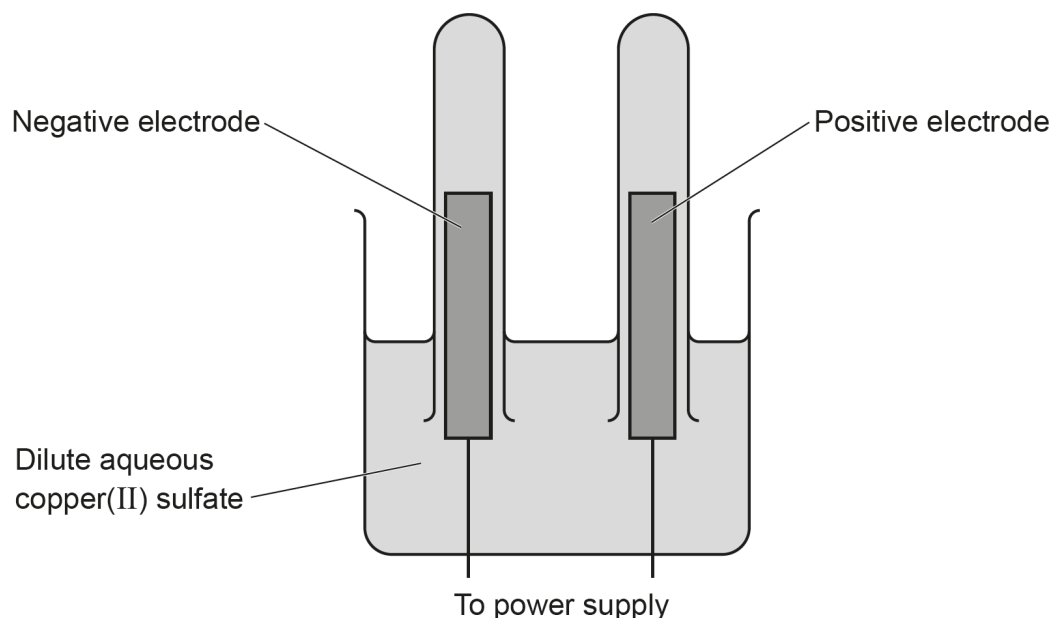
Many candidates had clearly not considered the sizes of the ions. All three alternative responses were used by less successful candidates.

Question 9 (a)

9 A student does an electrolysis experiment.

They pass electricity through dilute aqueous copper(II) sulfate using inert electrodes.

The diagram shows the apparatus they set up.



(a) Oxygen gas forms at the positive electrode.

Which **two** statements give correct reasons why oxygen forms at the positive electrode?

Tick (✓) **two** boxes.

Copper reacts with water to form oxygen.

☐

Hydroxide ions from water react to form oxygen.

☐

Non-metals usually form at the positive electrode.

☐

The electricity causes water to evaporate around the electrode.

☐

[2]

Most candidates were familiar with the collection of oxygen in electrolysis.

Question 9 (b) (i)

(b) The student wants to find the rate that oxygen gas forms by measuring the volume of gas produced.

(i) Suggest **one** change to the apparatus so that the volume of oxygen gas can be measured.

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

Many candidates offered a gas syringe to measure the volume of gas, as this is commonly a good way to measure gas volume, it was accepted here. A graduated collection tube would be a more appropriate solution.

Question 9 (b) (ii)

(ii) Describe how the student uses the new apparatus and a stop watch to find the rate that oxygen gas forms.

Include in your answer:

- what results they need to collect
- how they use their results to find the rate.

.....
.....
.....
.....
.....
..... [2]

Although hinted in the question, many candidates did not identify that they needed to measure both volume and time. The idea that the rate was calculated by dividing volume by time was rarely offered.

Question 9 (c)

(c) The student measures the mass of the electrodes before and after the electrolysis.

The table shows their results.

	Negative electrode	Positive electrode
Mass before electrolysis (g)	10.2	10.4
Mass after electrolysis (g)	10.9	10.4

Explain what happens to the mass of each electrode during the experiment.

Positive electrode

.....

.....

Negative electrode

.....

.....

[3]

Most candidates described the mass changes given in the table, although a few read the table horizontally (suggesting one had increased and the other decreased). Very few candidates attempted to explain why the mass changes were as described.

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