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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/02 Summer 2023 series

Version 1

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Contents

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.

Paper 2 series overview

J260/02 is one of the four Foundation tier papers for the GCSE 9-1 examination for Combined Science. This unit links together different areas of chemistry within different contexts, some practical, some familiar and some novel. To do well on this paper, candidates need to be comfortable applying their knowledge and understanding to unfamiliar contexts and be familiar with a range of practical techniques that they should recognise from completing the required practical element of the course.

There is clear evidence that candidates have returned to the laboratory and that they are able to conduct practical work to support their understanding of many key chemical concepts. In particular Questions 3 and 11 were well answered by many candidates dealing with titrimetric analysis and chromatography. Where candidates could still improve further is in applying their understanding of mathematical concepts in a science context. There is evidence to suggest that candidates do not always use the transferrable skills developed in one curriculum area to support their answers in a different subject area.

Candidates made good use of the time allowed and there was little evidence to suggest that they were rushing to complete the paper. The final two questions on the Foundation paper are common with the Higher tier paper. Many candidates at Foundation level not only attempted to answer these questions, but they often gained the majority of the marks available, particularly on Question 11.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• demonstrated knowledge and understanding relating to atomic structure and the periodic table in Questions 1 (a) – 1 (c) and Question 4 (a) • could identify the key steps in a titration in Questions 3 (b) and 3 (c) • identified many features of organic substances in Question 6 • were able to discuss the role of carbon dioxide emissions and levels in the atmosphere and link these to the effect on global average temperatures in Question 10 (b).	• struggled with the mathematical content in Questions 3 (c) (ii), 7 (c) and 8 (b) • did not always read the instructions given in the stem of the question, and so did not score marks that were readily accessible in Questions 1 (a), 1 (b) (i), 2 (a) and 10 (a) (i) • produced a response to Question 9 (c) that was limited to Level 1 as they were unable to give a valid explanation for how oxygen and hydrogen are produced in the electrolysis of sodium chloride.

Questions 1 (a), 1 (b) (i) and 1 (b) (ii)

1 The diagram shows part of Mendeleev's Periodic Table.

B 11	C 12	N 14	O 16	F 19
Al 27	Si 28	P 31	S 32	Cl 35.5
		As 75	Se 79	Br 80
In 115	Sn 119	Sb 122	Te 128	I 127

(a) Give the symbols of the **two** elements shown in the diagram which are **not** in order of atomic mass.

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

(b) Mendeleev left gaps for elements that had **not** been discovered.

(i) Name the **two** elements that had **not** been discovered when Mendeleev wrote his Periodic Table.

Use the diagram and the Data Sheet.

.... and .... **[2]**

(ii) Describe how the discovery of new elements supported Mendeleev's decision to leave gaps.

....

.... **[1]**

This set of three questions should have been readily accessible to candidates, especially Questions 1 (a) and 1 (b) (i) where candidates had access to the printed copy of the periodic table on the back page of the question paper. The most common mistakes evident in Question 1 (a) were candidates giving the names of elements when the question specifically asked for the symbols. Then in Question 1 (b) where the candidates were asked to provide the names many wrote in the symbols. Teachers need to make sure that candidates have access to questions of this type and practise answering them by referring to the copy of the periodic table that is provided as part of the question paper.

Assessment for learning

In Question 1 (b) (ii) most candidates simply stated that new elements would be discovered to fill the gaps Mendeleev had left. This was insufficient, as it did not address the question asked. Candidates should be able to demonstrate their understanding about how elements in groups within the periodic table have similar properties. They need to link this with the idea that Mendeleev left gaps so that elements with **similar** properties when discovered could be grouped with other similar elements.

Questions 1 (d) (i) and 1 d (ii)

(d) Lithium reacts with cold water to produce hydrogen gas and a solution of lithium hydroxide.

(i) Complete the equation by adding the state symbols.

$2Li\ (......) + 2H_2O\ (......) \rightarrow 2\ LiOH\ (......) + H_2\ (......)$

[2]

(ii) Describe an experiment to show that the reactivity of the Group 1 elements increases down the group.

....

....

....

.... **[2]**

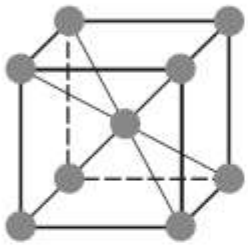
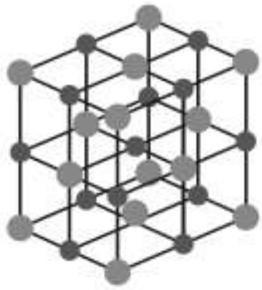
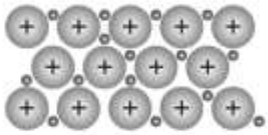
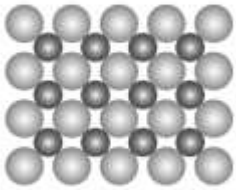
Many candidates knew that an appropriate experiment involved adding the different alkali metals to water, but they did not link how this could be used to show how the reactivity increases, e.g. by increased rate of gas production going down the group / potassium ignites on contact but lithium does not, etc. and so they often only scored 1 mark for this question.

Assessment for learning

Many candidates still struggle to assign the correct state symbol to species in chemical equations, and it would be an opportunity when studying the chemistry of the alkali metals for teachers to build in time to practise writing equations to describe reactions including assigning state symbols to the appropriate species.

Question 2 (a)

2 The table shows the structures and some properties of sodium and sodium chloride.

	Sodium	**Sodium chloride**
Three - dimensional structure		
Two - dimensional structure		
Electrical conductivity	Good conductor when solid or liquid	Good conductor when liquid or in aqueous solution only
Melting point (°C)	98	801

(a) Sodium is a metal and sodium chloride is an ionic compound.

Draw lines to connect sodium and sodium chloride with the correct structure and nature of their chemical bonds.

Giant lattice		Attraction between ions and mobile electrons
	Sodium	
Big molecule		Attraction between oppositely charged ions
	Sodium chloride	
Simple molecule		Attraction between atoms

[3]

This question was well answered by the more successful candidates on this paper. Less successful responses including extra links that were contradictory to the accepted answer, for example if they linked both giant lattice and small molecule to sodium then the contradictory connection negated the acceptable connection.

Questions 2 (b), (c) and (d)

(b) Complete the sentences to explain the electrical conductivity of sodium and sodium chloride.

Put a (ring) around each correct option.

Sodium is a good conductor of electricity when solid because its **atoms / electrons / ions** are **fixed / mobile**.

Sodium chloride conducts electricity when liquid because its **atoms / electrons / ions** are **fixed / mobile** but does not conduct when solid because they are **fixed / mobile**.

[3]

(c) Complete the sentences to explain the difference in melting points of sodium and sodium chloride.

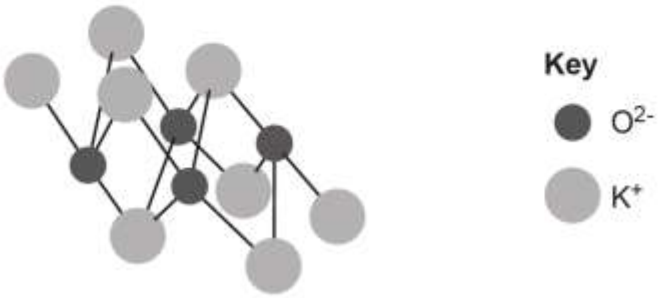
Put a (ring) around each correct option.

The melting point of sodium chloride is **higher / lower / the same** compared to the melting point of sodium.

This is because the forces of attraction between the particles in sodium chloride are **higher / lower / the same** compared to those in sodium and so the energy needed to separate the particles is **higher / lower / the same**.

[2]

(d) The diagram shows the structure of potassium oxide.



What is the chemical formula of potassium oxide?

Tick (✓) **one** box.

K_2O ☐

KO_2 ☐

KO ☐

[1]

Questions 2 (b) – 2 (d) were multiple choice questions designed to assess candidates' knowledge and understanding of ionic structures. The majority of candidates did well here and scored at least 4 of the marks available. The only common error was to see KO_2 selected as the formula of potassium oxide in Question 2 (d).

Questions 3 (a), (b) (i) and (b) (ii)

3 Acids react with alkalis to form salt and water. This reaction is called neutralisation.

An example is shown:

$NaOH + HNO_3 \rightarrow NaNO_3 + H_2O$

(a) Complete the sentence to describe neutralisation in terms of ions.

Use the ions and formulae.

H^+ **Na^+** **OH^-** **NO_3^-** **$NaNO_3$** **H_2O** **HNO_3** **NaOH**

Neutralisation is when .... ions from an acid react with .... ions from an alkali to form .... molecules. **[2]**

(b) Felix wants to find the concentration of some dilute nitric acid using a titration.

He finds this simple method in a book:

- measure 25.0 cm^3 sodium hydroxide solution into a conical flask using a measuring cylinder
- add dilute nitric acid from a burette to the sodium hydroxide solution until neutralisation
- write down the volume of acid used.

(i) The method does not say how he will know when neutralisation has occurred.

Explain what should be added to the method so that he knows when to stop adding acid.

....

....

....

.... **[2]**

(ii) Felix uses the method to get a rough idea of the volume of acid needed.

He makes changes to the method to improve the quality of his data.

Draw lines to connect the description of the change in method with the explanation for the change.

Description	**Explanation**
Add acid drop by drop when nearly neutral	Exactly the same volume of sodium hydroxide used each time
Repeat the experiment until the volumes of acid used are close together	So that too much acid is not used
Use a pipette instead of a measuring cylinder to measure the sodium hydroxide	To check that the results are repeatable

[2]

Question 3 as a whole was addressing one of the key practical areas that candidates should have visited as part of the required practical element of the course. Part (a) asked candidates to identify the species involved in a neutralisation reaction and to insert these into the appropriate spaces in the cloze text passage. Many candidates did not score more than 1 mark here, as they often chose combinations such as Na^+ and OH^- forming NaOH, or Na^+ and NO_3^- forming $NaNO_3$ rather than correctly identifying H^+, OH^- and H_2O.

However, the next two parts of this question were well answered. There were many good answers in Question 3 (b) (i), where it was recognised that an indicator was required that would change colour to indicate when the reaction was complete. Then in Question 3 (b) (ii), the vast majority of candidates scored both marks by correctly linking the features on the left hand side with the explanations on the right hand side.

Questions 3 (c) (i) and (c) (ii)

(c) The table shows the results of Felix's experiment.

	Rough	Repeat 1	Repeat 2	Repeat 3
Second reading on burette (cm^3)	27.6	23.4	46.9	23.9
First reading on burette (cm^3)	0.0	0.0	23.4	0.5
Volume used (cm^3)	27.6	23.4	23.5	23.4

(i) Complete the sentence to evaluate the quality of his repeated results.

Put a (ring) around each correct option.

These results are **high / low** quality because the repeated results are

close together / far apart / the same.

[1]

(ii) Calculate the mean of the repeated results.

Give your answer to **1** decimal place.

Mean = ... cm^3 **[3]**

Many candidates scored the mark for Question 3 (c) (i), by recognising that the quality of the results collected could be measured by their proximity to one another. However, they did not always translate this into their attempted calculations for Question 3 (c) (ii). There are essentially two parts to this question. The first task is to select the most appropriate data to use to calculate their mean volume Then candidates needed to calculate the mean, giving their answer to 1 decimal place.

Exemplar 1

	Rough	Repeat 1	Repeat 2	Repeat 3
Second reading on burette (cm^3)	27.6	23.4	46.9	23.9
First reading on burette (cm^3)	0.0	0.0	23.4	0.5
Volume used (cm^3)	27.6	23.4	23.5	23.4

(i) Complete the sentence to evaluate the quality of his repeated results.

Put a (ring) around each correct option.

These results are **high / low** quality because the repeated results are

close together / far apart / the same.

[1]

(ii) Calculate the mean of the repeated results.

Give your answer to **1** decimal place.

23.4 + 46.9 + 23.9 = $\frac{94.2}{3}$ = 31.4

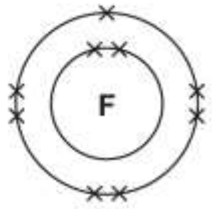
Mean = 31.4 cm^3 **[3]**

There seemed to be a clear misunderstanding about how to select the appropriate data to calculate their mean. In this exemplar the candidate has chosen to use the second (final) volume readings from the burette and has added these together. They have then divided this by the number of values chosen. In carrying out this calculation, the candidate has demonstrated that they understand how to calculate the mean, but unfortunately selected the incorrect data to use from the table. Marking point 3 from the mark scheme was still awarded where the calculated mean was correctly given to 1 decimal place as instructed in the question..

Question 4 (a) (ii)

(ii) **Fig. 4.1** shows the electron arrangement of a fluorine atom.

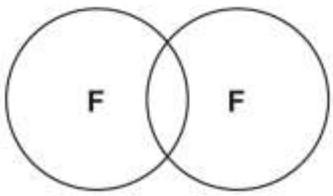
Fig. 4.1



Complete **Fig. 4.2** to show the dot and cross diagram for F_2.

Show outer shell electrons only.

Fig. 4.2



[2]

This was a good question to assess candidates' knowledge and understanding of chemical bonding. The more successful candidates knew that electrons are shared between the atoms: they correctly inserted a pair of electrons in the overlap area of the diagram, and they knew that each atom needed to have 8 electrons in total in their outer electron shell. Less successful candidates often only scored the first of these marks, as they correctly drew two dots or crosses in the overlap section and often only used the remaining pattern for each atom, thus ending up with an unpaired electron on each fluorine atom.

Question 4 (b)

(b) The halogens all react with iron wool.

The reactivity of the halogens decreases down Group 17(7).

The table shows the reactions when iron wool is put into jars containing each gaseous halogen.

Halogen	Reaction with iron wool
Fluorine	Cold iron wool burns.
Chlorine	Hot iron wool burns vigorously.
Bromine	
Iodine	Hot iron wool reacts slowly.

Predict the reaction of bromine with iron wool.

....

.... **[1]**

Successful candidates used a variety of terms to convey the idea of the iron wool burning at a rate in between that of chlorine and iodine to gain this mark, and the only common incorrect response was to say that 'cold iron wool ….' This is wrong as cold iron wool will not react or will react extremely slowly with bromine. Correct responses were characterised by a clear indication that the speed of reaction was less than that with chlorine, but greater than that with iodine.

Questions 5 (a) (i) and (ii)

5 Ammonia is manufactured by reacting nitrogen and hydrogen gases together.

(a) The reaction to produce ammonia is reversible.

(i) Complete the equation with the symbol to show that it is reversible.

$N_2(g)$ + $3H_2(g)$ .... $2NH_3(g)$ **[1]**

(ii) Why does this reaction not give a 100% yield?

....

.... **[1]**

For this question many candidates knew the appropriate symbol to define an equilibrium reaction. However, they could not explain why the reaction did not give a 100% yield, as they simply restated the information in the question and said that the reaction is reversible. There was no mark available for simply restating the question. Candidates needed to expand on this with a comment such as 'ammonia reacts to re-form nitrogen and hydrogen' in order to demonstrate that they understood what a reversible reaction is.

Questions 6 (a) (i) and (ii)

6 Crude oil is a mixture of hydrocarbons.

(a) **(i)** Give **one** reason why modern life depends on crude oil.

....

.... **[1]**

(ii) Give **one** reason why we **cannot** depend on crude oil in the future.

....

.... **[1]**

Successful candidates often scored both marks here. They could identify that we make substances such as petrol from crude oil that we use every day, and also knew that crude oil as a natural resource is finite. Less successful candidates often scored 1 of these marks but there was no distinct pattern to discern which question was more accessible to candidates at this level.

Question 6 (b) (i)

(b) Carbon bonds covalently with more carbons and with other elements to form lots of different compounds.

(i) How many covalent bonds does each carbon atom form?

.... **[1]**

Again, the more successful candidates scored this mark, but lower scoring candidates who attempted it provided a range of incorrect values with no discernible pattern.

Questions 6 (c) (i) and (ii)

(c) Hydrocarbons are compounds of carbon and hydrogen.

Alkanes are one type of hydrocarbon. They have the general formula C_nH_{2n+2}.

(i) What is the formula of the alkane with five carbons?

.... **[1]**

(ii) Hexane has the formula C_6H_{14}.

What is its empirical formula?

.... **[1]**

Despite being given the general formula for an alkane in the stem of the question, many candidates did not attempt this question, and subsequently did not attempt Question 6 (a) (ii). Where candidates did attempt Question 6 (a) (i), there were a range of incorrect responses, often characterised by simply replacing the n in the formula by a number 5 giving the molecular formula as C_5H_{25+2} . Very few candidates attempted to give an empirical formula, and there were many scripts where no attempt had been made with this question.

Assessment for learning

Candidates should have the opportunity to practise writing molecular formulae for common groups of organic molecules – alkanes and alkenes – from their general formulae and also to derive the empirical formula of a range of molecules from their given molecular formulae.

Question 6 (d) (i)

(d) The table gives some information about ethene, poly(ethene) and diamond.

	Ethene	**Poly(ethene)**	**Diamond**
Formula	C_2H_4	$(C_2H_4)_n$	C
Bonding	....	Covalent	....
Structure	....	Large molecule	....
Melting point (°C)	–169	Approximately 110	Approximately 4000

(i) Complete the table. **[3]**

There were lots of candidates scoring 2 marks here, but with no clear pattern about incorrect responses. The more common incorrect response saw ethene described as having ionic bonding, or diamond's structure being labelled as a large molecule similar to poly(ethene). More successful candidates usually scored 2 marks for correctly identifying that ethene and diamond contain covalent bonding and that ethene is a small molecule.

Question 6 (d) (ii)

(ii) Explain why the melting point of poly(ethene) is higher than the melting point of ethene.

Use ideas about chain length and forces between the particles in your answer.

....

....

....

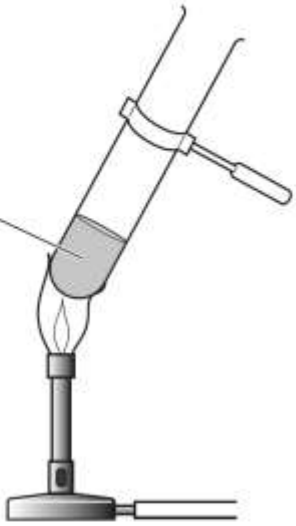
.... **[2]**

Lower scoring candidates often did not attempt this question. However, when candidates did engage with the question, they usually scored at least 1 mark for recognising that poly(ethene) has a longer chain / larger molecule than ethene. The most successful candidates also identified that these longer chain molecules had stronger intermolecular forces and that this resulted in poly(ethene) having a (much) higher melting point.

Question 6 (e)

(e) Umi wants to check the melting point of the poly(ethene).

They have a sample of solid poly(ethene) in a test tube.



Describe how they can measure the melting point of the solid poly(ethene).

....

....

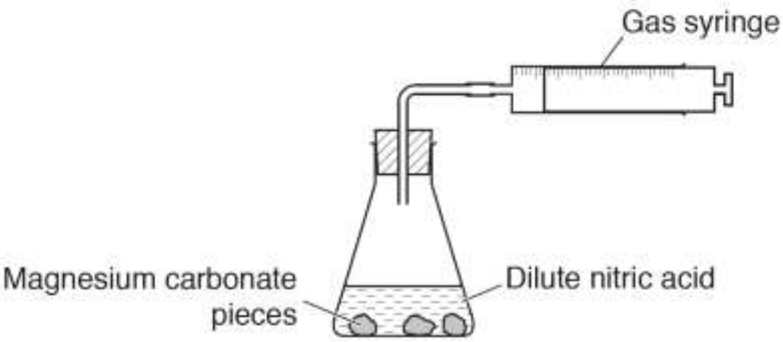
....

.... **[2]**

This question was well answered by many candidates, even if they had not attempted the previous question. Most scored the mark for including a thermometer to the practical set up, and then stated that they needed to record the temperature when the poly(ethene) melted / turned to liquid, to score a second mark.

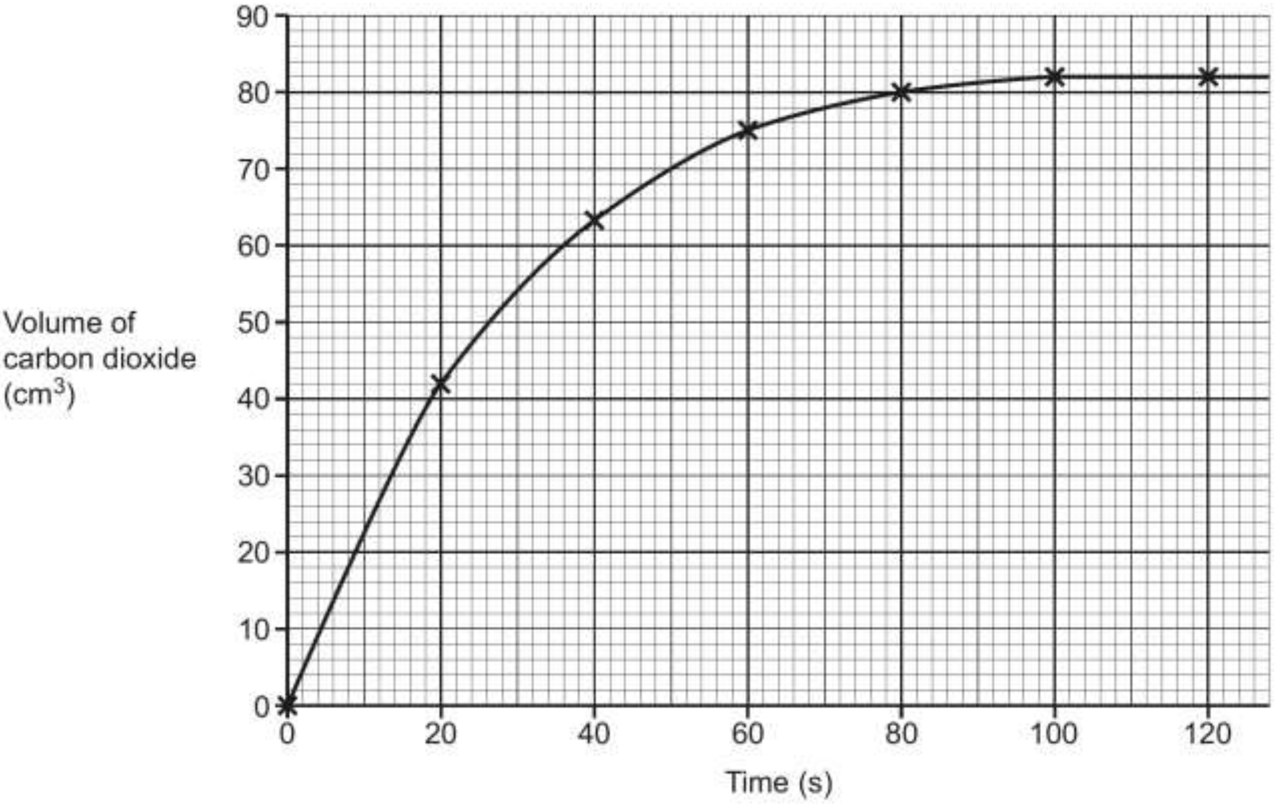
Questions 7 (a) and (b)

7 Sasha uses this apparatus to find the rate of the reaction between pieces of magnesium carbonate and dilute nitric acid.



Sasha adds the pieces of magnesium carbonate to the dilute nitric acid and measures the volume of carbon dioxide collected every 20 seconds.

Sasha draws this graph.



(a) What is the total volume of carbon dioxide collected?

Volume of carbon dioxide = ... cm^3 **[1]**

(b) How long does it take for the reaction to finish?

Time taken = ... s **[1]**

Many candidates scored both marks here and there were very few scripts where candidates had not attempted the questions. The common errors identified were in reading the scale in Question (7) (a) and stating that the total volume of carbon dioxide collected was 80 cm^3 , or in Question 7 (b) thinking that the reaction had finished at the end of the curve at 120 seconds rather than at the point where it just levels off and no more gas is being produced, i.e. at 100 seconds.

Question 7 (c)

(c) Draw a tangent to the curve and use it to find the rate of reaction at 40 seconds.

Rate of reaction = ...cm^3/s **[4]**

Very few candidates attempted this question. The Science specification requires candidates to be able to draw a tangent and interpret it within the area of reaction rates. Whilst this is a mathematical skill, it is one that needs to be carefully developed within science contexts and as such teachers are advised not to treat this as a transferable skill between curriculum areas.

Assessment for learning

Candidates should have the opportunity to practise drawing appropriate tangents to curves, and to calculate the gradients of the tangents produced. This could be achieved when studying a continuous monitoring method for rate determination, such as in the reaction between magnesium ribbon and dilute acid.

Question 8 (a)

8 Atoms are too small to see with the naked eye.

Models can be used to help show the size of atoms compared with objects that we can see.

(a) What is the typical size of atoms and small molecules?

Put a (ring) around the correct option.

1×10^{-10} m **1×10^{-6} m** **1×10^{-2} m** **1 m**

[1]

Many candidates who answered this question made the correct choice for the size of atoms, and the only common incorrect response was to choose 1 x 10^{-6} m. This is an aspect that historically candidates had struggled with.

Question 8 (b)

(b) A sphere with a diameter of 2 cm is used as a model of an atom.

Calculate the diameter of a model of a tennis ball on the same scale.

Give your answer in metres, **m**.

Use this formula:

$$\frac{\text{diameter of model atom}}{\text{diameter of a model of a tennis ball}} = \frac{1}{7 \times 10^{8}}$$

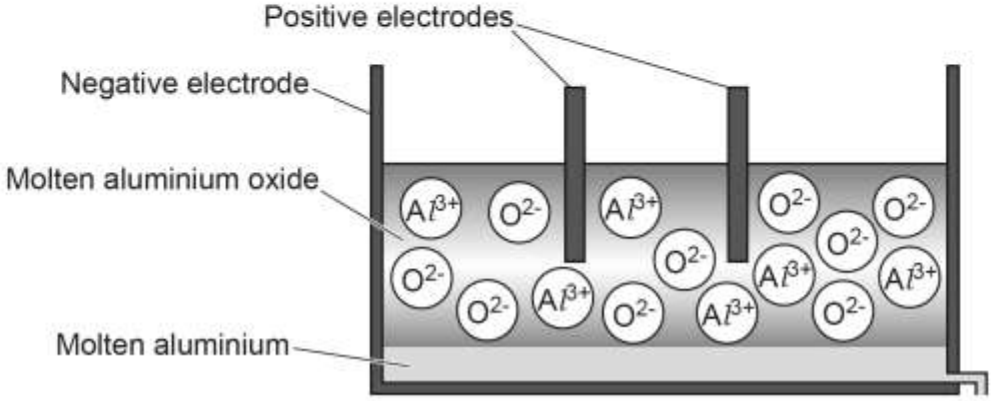
Diameter of a model of a tennis ball = ... m **[3]**

As with Question 7 (c), many candidates did not attempt this question. Those who did often simply tried to evaluate the expression given or used 2 (from the first line of the question) and attempted to divide this by 7 x 10^8. In both cases it was not unusual to see incorrect evaluations. The other attempts seen often involved multiplying by 7 x 10^8 leading to values of 1.4 (or 2.8) x 10^8 m.

Questions 9 (a) (i), (ii) and (iii)

9 The diagram shows how aluminium is extracted from its ore by electrolysis of molten aluminium oxide.

It is carried out at high temperature with carbon electrodes.



(a) (i) Complete the **balanced symbol equation** for the decomposition of aluminium oxide by electrolysis.

$2Al_2O_3 \rightarrow$ .... Al + ... O_2 **[2]**

(ii) During electrolysis, reactions take place at the positive and negative electrodes.

Complete the table to explain the reactions at each electrode.

Use the diagram **and** the symbol equation to help you.

Electrode	Formula of ions attracted	Loss or gain of electrons	Product
Positive			
Negative			

[2]

(iii) Explain why carbon dioxide is also produced.

....

.... **[1]**

Most candidates did attempt to balance the equation, and often scored marking point 1 for correctly stating that 4 moles of aluminium would be produced. A significant proportion of candidates were not able to balance the equation fully and gave the number of moles of oxygen produced as 2.

In Question 9 (a) (ii), the intent was that candidates should be able to recognise that opposite charges attract, as this is a fundamental idea in physics as well as chemistry. Therefore, it was hoped that candidates could identify that the aluminium ions, Al^{3+} would be attracted to the negative electrode, and that the oxide ions O^{2-} would be attracted to the positive electrode in order for both ions to be discharged. This was not evident in candidates' responses and it was not unusual to see positive ions being attracted to the positive electrode and vice versa for the negative ions.

Also a common response that did not gain any credit was ticking boxes which demonstrated that quite often candidates had not read the instruction given to them in the stem of the question.

Question 9 (b)

(b) Zinc is extracted from its oxide using carbon:

$$2ZnO + C \rightarrow 2Zn + CO_2$$

Which **two** statements explain why aluminium must be extracted by electrolysis and **not** by reaction with carbon?

Tick (✓) **two** boxes.

Aluminium does not react with carbon. ☐

Aluminium is more reactive than carbon. ☐

Aluminium is less reactive than zinc. ☐

Aluminium oxide does not react with carbon. ☐

[2]

Type your commentary here

Question 9 (c)*

(c)* When salts are dissolved in water the solution contains H^+ and OH^- ions from the water as well as the ions from the salt. The products formed depend on the tendency of the ions to lose or gain electrons.

The table shows the tendency of ions to lose or gain electrons.

Positive ions		Negative ions	
Li^+	↓ Increasing tendency to gain electrons	SO_4^{2-}	↓ Increasing tendency to lose electrons
Na^+		NO_3^-	
Zn^{2+}		Cl^-	
Fe^{2+}		Br^-	
H^+		OH^-	
Cu^{2+}			

Jamila does an experiment to electrolyse an aqueous solution of sodium chloride.

She identifies the products formed as oxygen and hydrogen.

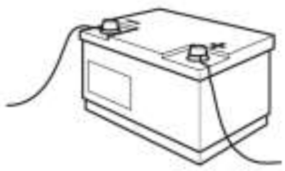
She uses this apparatus.


Carbon rods


Wires with clips


Aqueous solution of sodium chloride


Beaker


Battery

Describe how Jamila should use the apparatus to electrolyse an aqueous solution of sodium chloride, **and** explain why oxygen and hydrogen are formed.

....

....

....

....

....

.... **[6]**

Many candidates attempted this question and usually scored marks at Level 1. They could describe how to use the apparatus shown on page 22 of the question paper in order to carry out an electrolysis experiment involving sodium chloride solution. Some candidates also gave an indication of what they might see as the electrolysis progressed. This was often where candidates completed their written answer, and very few made any attempt to try to explain how oxygen and hydrogen were formed in the reaction. Had they made an attempt to explain how the gases are produced they could have accessed Level 2 as shown in exemplar 2.

Exemplar 2

- she should put aqueous solution of sodium chloride into the beaker
- Then she should place the carbon rods inside the beaker and attach the ends to the wires via the clips.
- She should put the other clips to the battery and shes ready to ~~the~~ experiment.
- Oxygen and hydrogen are formed as the H^+ and OH^- atoms are reacting as well as the sodium chloride

[6]

This candidate has described how to use the apparatus to conduct an electrolysis reaction and has identified that hydrogen and oxygen are produced because there are H^+ and OH^- atoms in the solution. There is a partial explanation for how the gases are formed, but the incorrect use of 'atoms' lowered the mark from 4 to 3. Had the terminology been correct this would have scored 4 marks.

Question 10 (a) (i)

10 The combustion of fossil fuels for energy produces harmful substances.

(a) (i) Draw lines to connect each **harmful substance** with the description of its major source.

Harmful substance	Major source
Carbon monoxide	Combustion of sulfur impurities in fossil fuels
Particulates	Incomplete combustion of fossil fuels
Nitrogen oxides	Oxidation of nitrogen at high temperatures.
Sulfur dioxide	

[2]

This was the first of two overlap question with the higher tier on the question paper and the vast majority of candidates not only attempted these two questions, but also scored a significant proportion of the marks available.

Most candidates attempted this question and often scored 1 mark. They had probably not read the instruction to link **each** harmful substance to its source and so often drew only three links between substances on the left and the major source of the (harmful) substance on the right. Most who engaged with this question scored the marks for linking sulfur dioxide and nitrogen oxides to their correct source.

Questions 10 (a) (ii) and (iii)

(ii) Explain **one** problem caused by increased amounts of sulfur dioxide in the atmosphere.

....

....

....

.... **[2]**

(iii) Describe **one** method that is used to decrease the amount of harmful substances put into the atmosphere by petrol cars.

....

.... **[1]**

In Question 10 (a) (ii), where candidates did identify that sulfur dioxide was a major contributor to the formation of acid rain, they often gave vague ideas of the problems caused by this. Sometimes these ideas were creditworthy, such as 'it may harm/kill fish if it gets into lakes' which was a major concern in Scandinavian countries worried about the effect of emissions from UK power stations at the end of the last century.

Other responses were not acceptable such as 'it is harmful' this was not precise enough and could have scored had they given a suitable example of how it may cause harm. The most commonly seen incorrect response was to state that sulfur dioxide was a greenhouse gas and was responsible for climate change.

In Question 10 (a) (iii), the responses possibly reflected where candidates lived. It was not unusual to see candidates discussing low emission zones in city centres, identifying the move towards electric/hybrid cars and to suggest using smaller engines as ways of reducing the emissions produced from petrol engines. These responses were more evident than those expected, and of these the only one that occurred with any frequency was the use of catalytic converters.

Question 10 (b)

(b) The combustion of fossil fuels produces carbon dioxide. Most scientists now accept that recent climate change can be explained by increased carbon dioxide emissions.

Fig. 10.1 shows the change in concentration of CO_2 in the atmosphere over time.

Fig. 10.1

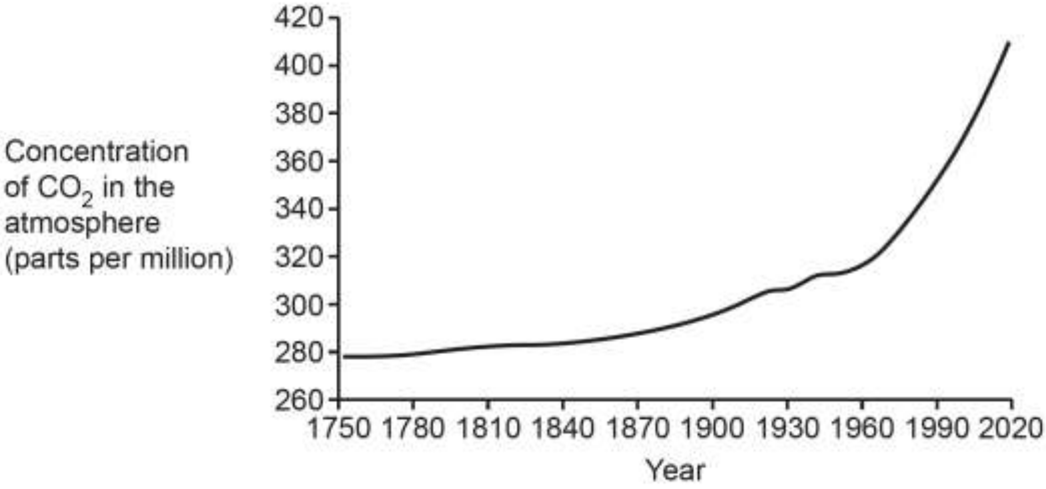


Fig. 10.2 shows the change in world carbon dioxide emissions from fossil fuels over time.

Fig. 10.2

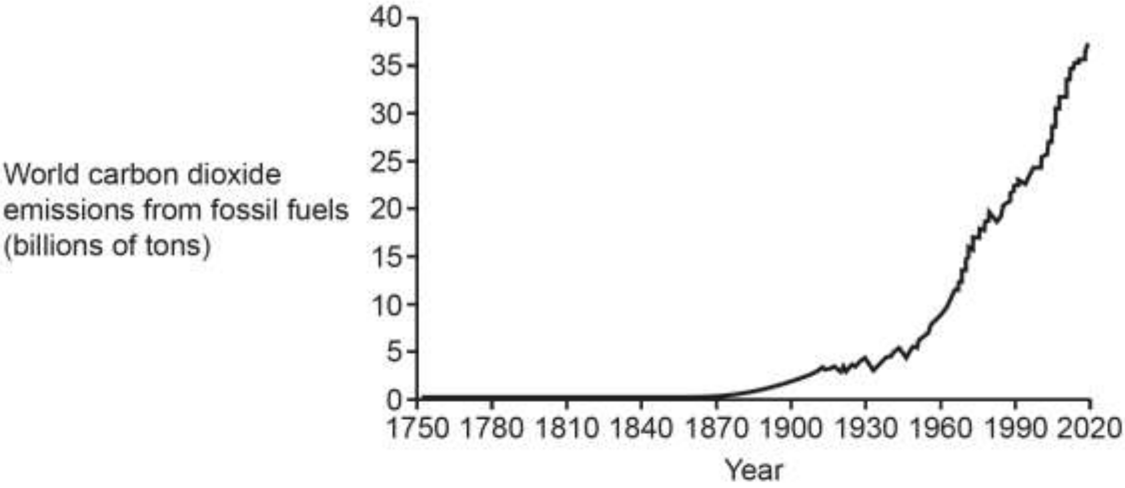
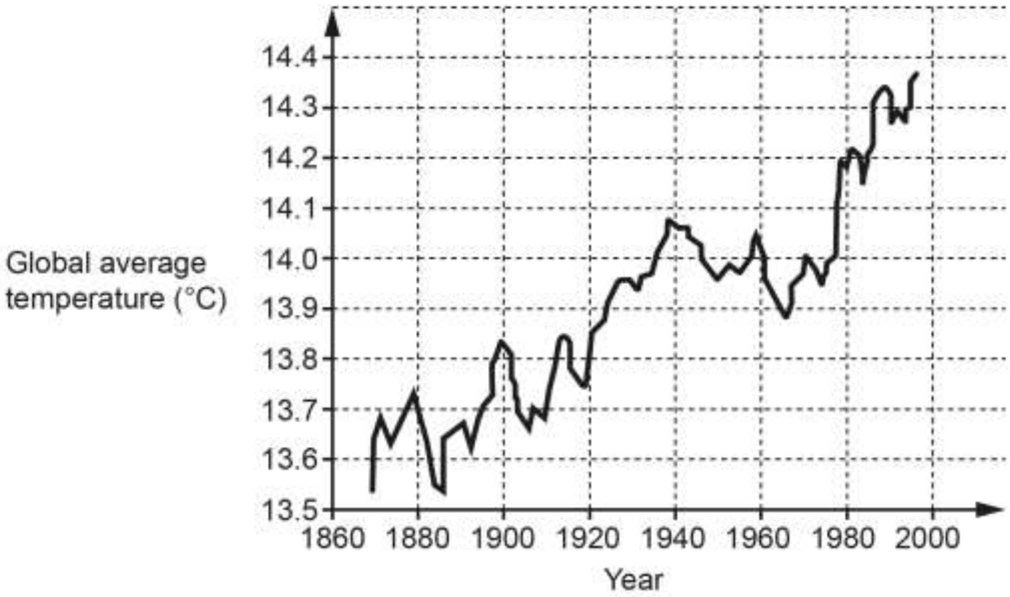


Fig. 10.3 shows the change in global average temperature over time.

Fig. 10.3



Describe the trends in **Fig. 10.1** and **Fig. 10.2 and** explain how this can be used with **Fig. 10.3** to show that human activity is causing the global temperature to increase.

....

....

....

....

....

.... **[4]**

Candidates made a good attempt to answer this question and often scored at least 2 of the 4 marks that were available. They regularly stated that the graphs in both Fig 10.1 and Fig 10.2 showed that levels of carbon dioxide were increasing, and then added to this by stating one of the following links – 'increased human activities such as driving cars releases carbon dioxide', or 'as carbon dioxide levels increased the global average temperature increased'. They often made one of these links but did not then try to develop it further. Even simply combining these would have allowed the candidate to score a third mark.

Exemplar 3

as the years go on the concentration of CO_2 in the atmosphere, the world carbon dioxide emissions from fossil fuels and the global average temperature rise this is because if humans keep buring fossil fuels - for example, the others will rise as well a result Theyre linked. [4]

This response is an example of this linking of ideas, and for this candidate to progress and score 4 marks they would have needed to identify an appropriate date that was common to Figs 10.1 and 10.2 and state that at his time, e.g. 1870, the concentration of carbon dioxide (in the atmosphere) and the levels of carbon dioxide emissions both increased rapidly. This point seemed to be the hardest link, and candidates struggled to articulate this clearly at this level.

Question 11 (a)

11 A company called Healthyfood make food colourings.

The diagram shows the label from one of their food colourings.

Healthyfood
Orange food colouring
All ingredients natural and tested
Ingredients: dye 1, dye 2, solvent

(a) A representative for Healthyfood says that the food colouring is pure.

A scientist says that it is not pure.

Explain the different meanings of the word 'pure' used by the Healthyfood representative and the scientist.

Healthyfood representative ....

....

Scientist ....

.... **[2]**

Question 11 was another good question for candidates, with many scoring at least 6 marks across the whole of the question.

In part (a), most candidates scored the first mark as they recognised that the food company representative was saying their product was pure because it contained natural products, or that it contained products that had been tested for safety. Where they did struggle was with the scientist. It was evident that they had not read the rubric carefully, as it makes it clear that the scientist says that the food colouring is not pure. So the question then is why does the scientist think it is not pure? The accepted answers were again linked to the product label and included broad statements such as 'it is not pure as it is a mixture', or 'it contains more than one ingredient'. The responses candidates produced were often along the lines of 'it is pure because it is a single substance' or 'it contains one element' and although these are statements used when discussing elements, compounds and mixtures, they do not address this question, as the answers should have been in terms of the evidence provided on the food colouring label.

Question 11 (d) (i) and d (ii)

(d) The chromatogram can be used to find the Rf values for the dyes.

(i) Measure the distance moved by dye 1 and by the solvent.

Use a ruler.

Distance moved by dye 1 = ... cm

Distance moved by solvent = ... cm **[2]**

(ii) Calculate the Rf value of dye 1.

Use this formula.

$$Rf = \frac{\text{distance moved by the dye (cm)}}{\text{distance moved by the solvent (cm)}}$$

Rf = ... **[2]**

This was a good pair of questions for candidates to finish the paper with, and many candidates scored at least half of the available marks. In Question 11 (d) (i), candidates were required to use a ruler to measure the distance travelled by the solvent from the base line drawn on the chromatogram up to the solvent front, and then to measure the distance that the food dye had travelled. For the solvent, the only acceptable answer was 5 cm, as it should have been obvious where to make this measurement. With the food dye there was some tolerance, as candidates may have measured to either the top, centre or bottom of the dye spot, and so any value in the range 2.4 – 2.6 cm was accepted.

In part (ii), candidates were given the equation to use in order to calculate an Rf value. In general, we were looking for answers given to 2dp, with the only exception being if they had measured the distance moved by the dye as being 2.5 cm, as this with the solvent having moved 5 cm gave an Rf value of 0.5 exactly, so this was accepted. Otherwise, the accepted answers should have been 0.48 or 0.52 from correct measurements being recorded in Question 11 (d) (i). We also allowed for candidates who had made errors in the original measurements in Question 11 (d) (i), but who used those measurements correctly in part (d) (ii) to score both marks if they showed their working and gave a correct evaluation of their expression. Examiners were encouraged to mark this question positively by use of ECF (error carried forward) between parts d (i) and d (ii) and this resulted in candidates who lost 1 or both marks in part d (i) still being able to score marks in part d (ii).

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