

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258

For first teaching in 2016

J258/01 Summer 2024 series

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Introduction

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

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

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

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

Would you prefer a Word version?

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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. This year far fewer candidates left large sections of the paper blank, which suggests a return of confidence following the disruption of previous years. Examiners never deduct marks, and even the weakest attempts at answers can sometimes demonstrate underlying understanding which is credit-worthy. Candidates have nothing to lose!

High scoring candidates were more than willing to apply their scientific knowledge and understanding to unfamiliar looking situations and scored well.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
<ul style="list-style-type: none">• 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• were aware that when writing formulae conventional capitals and lower-case letters are needed despite what they might do in the rest of their writing• had practical experience of handling laboratory glassware and performing such procedures as titrations for themselves.	<ul style="list-style-type: none">• read questions hastily due to the pressure of the examination, so missed part of what the question wanted• left questions blank• gave an answer to mathematical questions but no working.

Question 1 (a) (i)

1 Fuels such as diesel and petrol are made from hydrocarbons.

(a)

(i) Hydrocarbons are made from carbon and one other element.

What is the other element?

Put a ring around the correct option.

Chlorine

Hydrogen

Nitrogen

Oxygen

[1]

Almost all candidates were able to answer this introductory question.

Question 1 (a) (ii)

(ii) What is the main source of hydrocarbons?

..... [1]

Candidates answered this question confidently, and high scoring candidates were clearly familiar with the term 'source'. Most of the other answers were 'carbon' or sometimes 'hydrogen'.

Misconception



The term 'source' means 'where you get it from'.

Assessment for learning



It is always a good idea to look for the key words in a question and then either highlight or underline them.

Question 1 (b)

(b) Alkanes are hydrocarbons.

Which compound is an alkane?

Tick (✓) **one** box.

Butanoic acid

☐

Ethanol

☐

Methane

☐

Propene

☐

[1]

High scoring candidates recognised that methane is the alkane, with 'ethanol' being most candidates' choice.

Question 1 (c)

(c) Alkenes are also hydrocarbons. They can be used to make polymers.

Which statements about polymers are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
All polymers are made from alkenes.	<input type="checkbox"/>	<input type="checkbox"/>
Polymers are long chain molecules.	<input type="checkbox"/>	<input type="checkbox"/>
Polymers can be synthetic or naturally occurring.	<input type="checkbox"/>	<input type="checkbox"/>

[2]

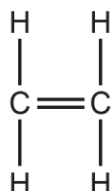
Almost all candidates knew that polymers are long chain molecules, and many were able to get all three boxes correct.

Question 1 (d) (i)

(d) Ethene is the monomer used to make a polymer called poly(ethene).

Fig. 1.1 shows the structure of ethene.

Fig. 1.1



(i) **Complete** the diagram below to show the repeating unit of poly(ethene).



[2]

Most candidates made a valiant attempt at this, but usually left in the double bond. High scoring candidates gave either the conventional repeating unit or drew several repeating units joined end to end. A wide range of alternative responses were seen.

Question 1 (d) (ii)

(ii) Describe what happens when ethene monomers react together to form poly(ethene).

.....

.....

.....

..... [2]

Again, the chief problem lay with recognising the role of the double bond. Many students found this question very challenging.

OCR support

Support with teaching concepts like polymerisation can be found in our [C4 Material Choices Delivery Guide](#), available from [Teach Cambridge](#).

Question 2 (a) (i)

2 Lithium is an element in Group 1 of the Periodic Table.

(a)

(i) Describe **one** physical property of lithium.

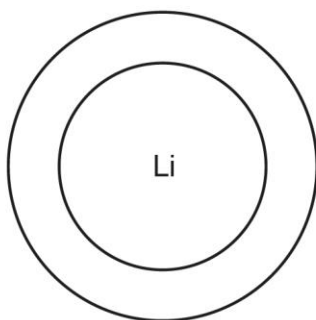
.....
..... [1]

Many candidates understood the meaning of 'physical' property and gave many sensible answers. Even where non-physical properties were given, the answers were carefully thought through and were relevant to Lithium.

Question 2 (a) (ii)

(ii) **Complete** the diagram to show the arrangement of electrons in an atom of lithium.

Use the Periodic Table.



[2]

This part was very well answered, with the majority of candidates successfully using the Periodic Table to work out that Lithium has three electrons, and correctly locating them in their shells.

Question 2 (b)

(b) Lithium reacts with water to form an alkaline solution and hydrogen gas.

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

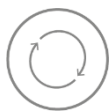
Include state symbols on the symbol equation.



[4]

Almost all candidates appreciated that the formula of water is made of 'H', '2' and 'O'. However, they seemed unfamiliar with the use of capitals and subscripts. Examiners marked generously, but a majority of candidates wrote 'h₂O', 'H₂O', or 'H₂o'. Some correctly named the lithium hydroxide, and the idea of state symbols was understood by many, even if they were uncertain which symbol to use. Almost all candidates put H or 2H instead of H₂.

Assessment for learning



It should be emphasised that a formula is a tool for conveying information to others rather than 'how I always write it'. Candidates should practise writing formulae such as H₂O so that they accustomed to using conventional capitals and clear subscripts.

Question 2 (c) (i)

(c) The reaction between lithium and water is exothermic.

(i) Describe what happens to the temperature during the reaction.

.....

..... [1]

Candidates have clearly been exposed to ideas of chemical energy and temperature and appreciated that as one increased the other decreased. However, there was a lot of confusion among candidates, with many answers along the lines of 'the temperature decreases as it produces heat'.

Exemplar 1

- (i) Describe what happens to the temperature during the reaction.

the temperature decreases releasing energy

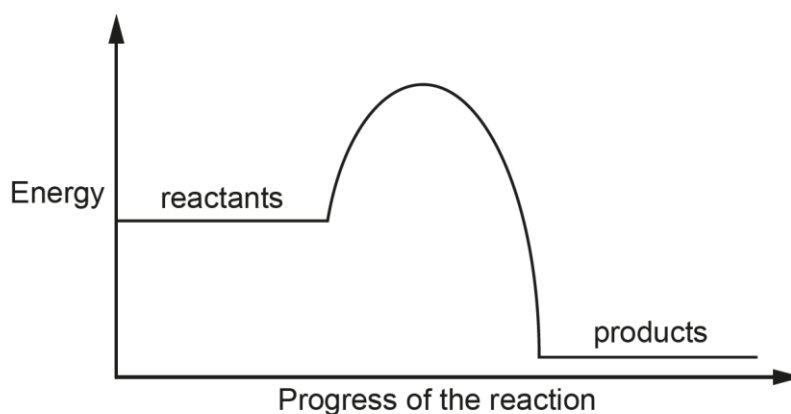
[1]

This sort of misunderstanding was very frequent.

Question 2 (c) (ii)

- (ii) The diagram shows the reaction profile for an exothermic reaction.

Draw an arrow on the diagram to show the activation energy.



[1]

Almost all candidates recognised the term activation energy and there were lots of different arrows pointing towards the hump. High scoring candidates drew a vertical arrow from the energy level of the reactants to the top of the curve and so gained credit.

Question 2 (c) (iii)

(iii) What is meant by the term activation energy?

.....

.....

.....

..... [1]

Almost all candidates had an intuitive understanding of the term, though found it much harder to articulate their thoughts clearly.

Assessment for learning



Answers such as 'the energy to activate the reaction' use the wording of the question but don't demonstrate understanding.

Question 3 (a) (i)

3 As the world population increases, the demand for safe drinking water also increases.

(a) The table shows the processes used in the treatment of groundwater to produce safe drinking water.

Process 1	Process 2	Process 3	Process 4
	Clarification	Filtration	Disinfection

(i) In **Process 1** large solid items such as leaves or plastic are removed from the groundwater.

Name **Process 1**.

..... [1]

Candidates made many good solid attempts to come up with the name for a process, not realising that in this case the term filtration could be used more than once.

Question 3 (a) (ii)

(ii) In **Process 4**, chlorine is used to kill microorganisms.

Describe a test and the result to identify chlorine.

Test

Result

.....

.....

.....

[3]

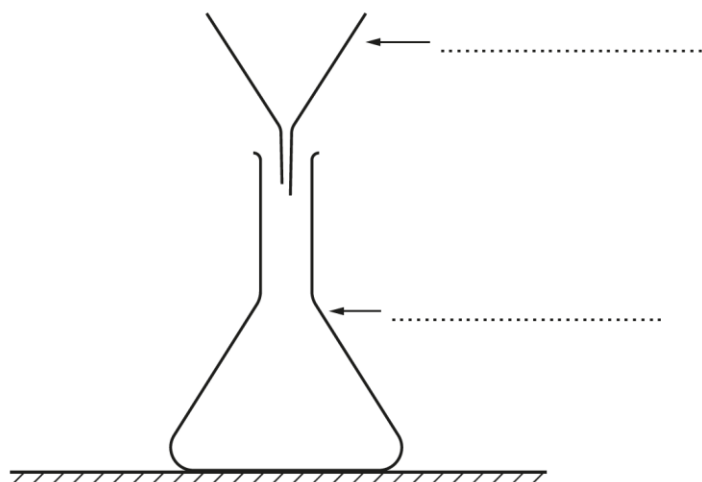
While candidates did not necessarily know the test for chlorine, they did make sensible attempts. The use of chlorine to kill organisms was a common response.

Question 3 (b) (i)

(b) A student removes some impurities from a sample of groundwater.

The diagram shows some of the apparatus they use.

(i) Complete the labels on the diagram.



[1]

High scoring candidates did appear to have experience of standard laboratory glassware. The conical flask was most frequently referred to as a beaker or a test tube by less experienced candidates.

Question 3 (b) (ii)

(ii) Describe how the student uses the apparatus to remove some impurities from the groundwater.

.....

.....

.....

..... [2]

Most had a rudimentary grasp of filtration, and high scoring candidates also described the need for filter paper.

Question 4 (a)

4 An engineer designs a new chopping board.



The chopping board must be made from a material that is **strong** and **lightweight**.

The table shows the properties of four materials.

Material	Type of material	Tensile strength (MPa)	Density (kg/m ³)	Melting Point (°C)
Glass	Ceramic	7	2500	1648
Acrylic	Polymer	70	1200	160
Concrete	Composite	5	2300	1550
Steel		400	7750	1425

(a) What type of material is steel?

Tick (✓) **one** box.

Alloy

☐

Ceramic

☐

Composite

☐

Plastic

☐

[1]

The term 'alloy' was very well known.

Question 4 (b)

(b) Explain why the engineer decides to use acrylic to make the chopping board.

Use information from the table.

.....

.....

.....

..... [2]

Candidates who scored well put the information into context. For example, rather than just quote the tensile strength, they pointed out that it was one of the highest, then went on to explain why this would be useful.

Question 4 (c) (i)

(c)

(i) How many times bigger is the tensile strength of acrylic than the tensile strength of glass?

Number of times bigger = [1]

Encouragingly, almost all candidates scored well here but a small minority subtracted one number from the other rather than calculate the ratio.

Question 4 (c) (ii)

(ii) What is the order of magnitude of this increase?

Put a ring around the correct option.

1 2 3 4

[1]

The concept of order of magnitude was not well known, despite it being in the mathematical skills section of the specification.

OCR support

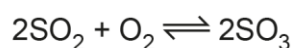


[Exambuilder](#) can be used to isolate mathematical skills questions from our bank of exam papers to specifically assess skills like order of magnitude. These could be used in conjunction with our [Mathematical skills handbook](#) and [Mathematical skills check in](#) resources.

Question 5 (a) (i)

5 Sulfur dioxide reacts with oxygen to give sulfur trioxide.

This is the equation for the reaction:



(a)

(i) How does the equation show that the reaction is reversible?

..... [1]

Candidates identified the symbol with confidence.

Question 5 (a) (ii)

(ii) The reaction reaches a dynamic equilibrium.

Complete the sentence about a dynamic equilibrium.

Put a ring around the correct option.

In a dynamic equilibrium, the rate of the forward reaction is **faster than / slower than / the same as** the rate of the reverse reaction.

[1]

High scoring candidates showed their clear understanding by choosing 'the same as', whereas many others went for the 'faster than' option.

Question 5 (a) (iii)

(iii) The reaction needs a catalyst to form the product.

Which of these is a property of a catalyst?

Tick (✓) **one** box.

It is used up during the reaction.

☐

It lowers the temperature of the reaction.

☐

It speeds up the reaction.

☐

It supplies energy to the reaction.

☐

[1]

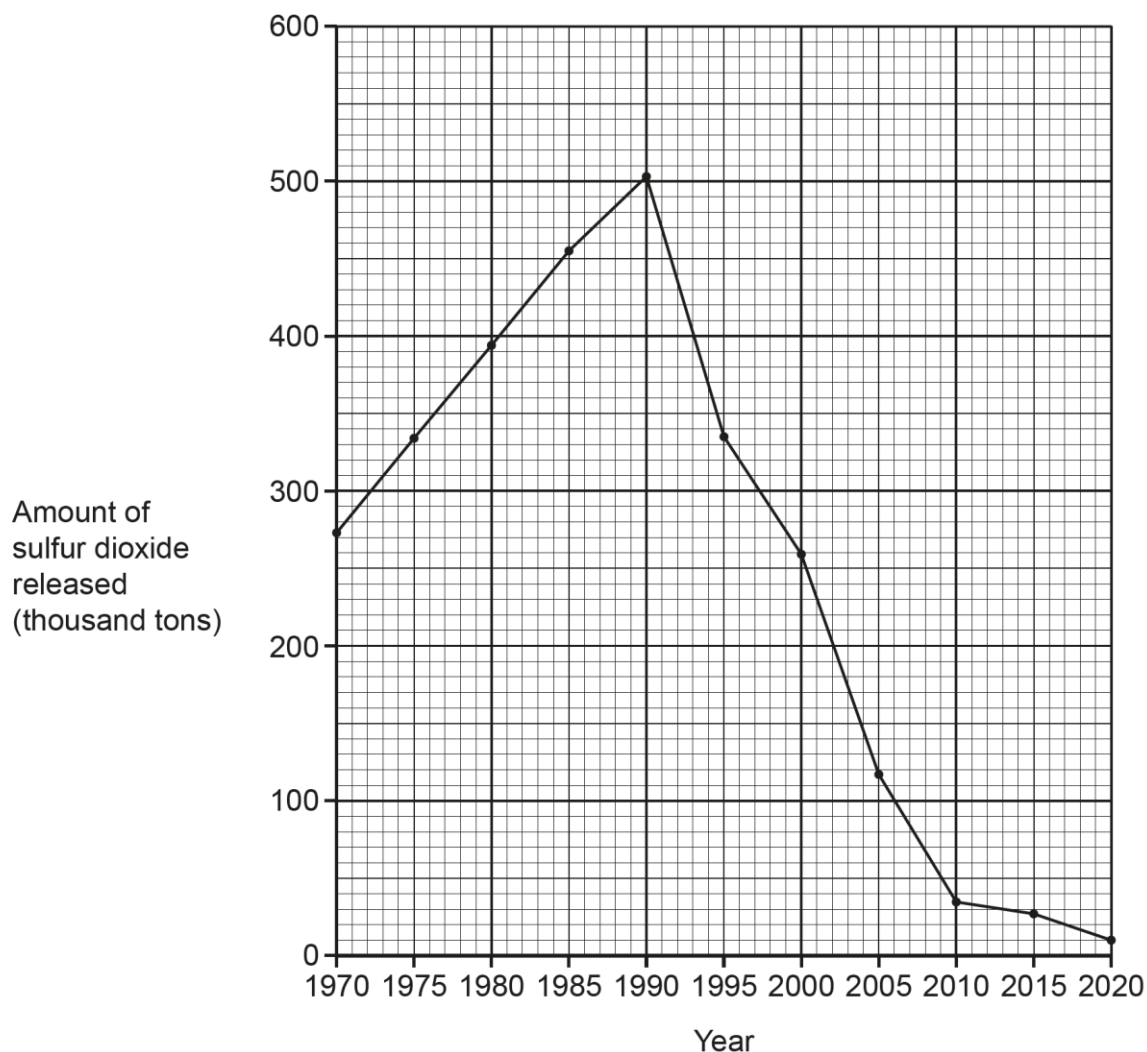
This was well answered, with the most common alternative being 'it supplies energy'.

Question 5 (b) (i)

(b) Sulfur dioxide is an air pollutant.

Sulfur dioxide is released when cars burn fuel that contains sulfur.

The graph shows the amount of sulfur dioxide released from cars from 1970 to 2020.



(i) Describe the pattern in changes to the amount of sulfur dioxide emissions from cars from 1970 to 2020.

.....

.....

.....

..... [2]

Most candidates discussed the increase and the decrease and quoted some of the numbers from the graph. One misconception was to say that the decrease was from 1995, not 1990.

Question 5 (b) (ii)

(ii) Which year was the **most** sulfur dioxide released?

..... [1]

This question was very well answered.

Question 5 (b) (iii)

(iii) State **one** environmental problem caused by an increase in the amount of sulfur dioxide.

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

There was a strong tendency to link all atmospheric problems to global warming, so many candidates did not score here.

Question 5 (b) (iv)

(iv) State **one** method used to reduce the amount of sulfur dioxide emissions from cars.

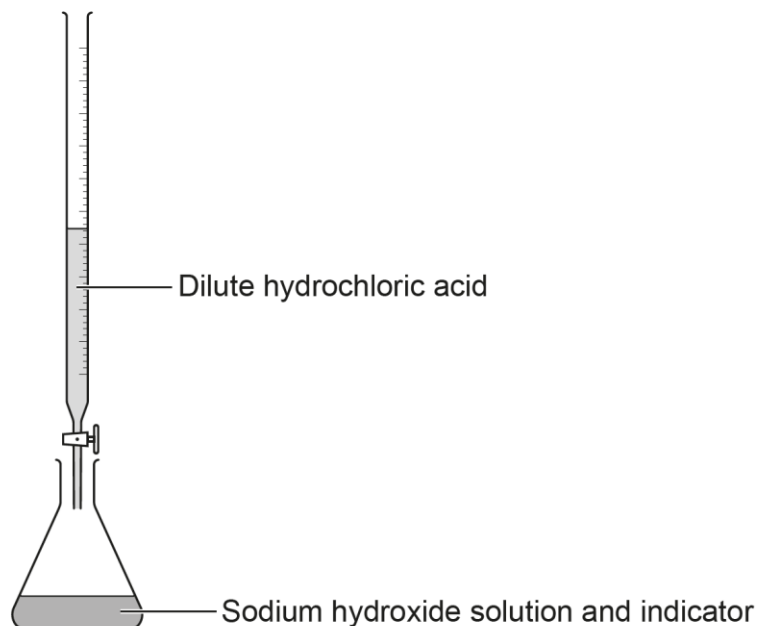
.....
..... [1]

There were many sensible answers given to this question.

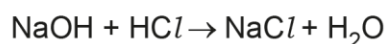
Question 6 (a) (i)

- 6 A student does a titration to find out the volume of dilute hydrochloric acid needed to fully react with sodium hydroxide solution.

The diagram shows the apparatus they used.



- (a) The equation shows the reaction between sodium hydroxide and hydrochloric acid.



- (i) What type of reaction occurs when sodium hydroxide reacts with hydrochloric acid?

..... [1]

'Endothermic' was a common response to this question.

Question 6 (a) (ii)

- (ii) Name the salt formed in the reaction.

..... [1]

High scoring candidates usually named sodium chloride correctly, and sea salt was a frequent answer given by others. As examiners were looking for the chemical identity of the salt they were unable to give it credit.

Question 6 (b) (i)

(b) The table shows the results.

	Titration		
	1	2	3
Burette reading at end (cm^3)	37.2	37.4	37.2
Burette reading at start (cm^3)		0.9	0.8
Volume added (cm^3)	36.6	36.5	36.4

(i) Calculate the burette reading at the start of titration 1.

Burette reading at the start of titration 1 = cm^3 [1]

This question was well answered.

Question 6 (b) (ii)

(ii) Calculate the mean volume added for the three titrations.

Mean volume added = cm^3 [2]

This question was even better answered than Question 6 (b) (i), with a large majority achieving both marks.

Question 6 (b) (iii)

(iii) Explain why an indicator must be used in the titration.

.....

.....

.....

..... [2]

Many candidates appreciated that the reaction was colourless, and so the first job of any indicator is to make the end point visible.

Exemplar 2

(iii) Explain why an indicator must be used in the titration.

..... To show the reaction is taking place /
..... finished as the solution doesn't change
..... colour or have visible signs

This candidate clearly expressed all the main components of the answer.

Question 6 (b) (iv)

(iv) Describe **one** way the student can make sure that the burette readings are as accurate as possible.

.....

.....

.....

..... [1]

While most candidates suggested repeating the experiment several times, those with practical experience of burettes discussed taking readings at eye level and adding the acid drop by drop. A significant minority suggested replacing the burette with a measuring cylinder or a measuring jug.

Question 7 (a) (i)

7 The modern model of the atom has developed over time.

(a) The table shows the ideas of three scientists.

(i) Complete the table to show the name of the scientist who had the idea that all matter is made up of atoms.

Scientist	Year	Idea
.....	1803	All matter is made of tiny particles called atoms.
Thomson	1897	An atom contains negatively charged particles called electrons.
Rutherford	1909	Atoms have a central positive nucleus.

[1]

Many candidates chose Bohr or Mendeleeev. Examiners had huge sympathy for those who missed the year and put Democritus.

Question 7 (a) (ii)

(ii) What is the name of the atomic model proposed by **Thomson**?

Tick (✓) **one** box.

Nuclear model

☐

Particle model

☐

Plum pudding model

☐

[1]

Plum pudding model was well known, with the particle model being the next most popular choice.

Question 7 (b)

(b) In 1913, Bohr discovered that electrons move around the nucleus of an atom in orbits.

What are these orbits called?

..... [1]

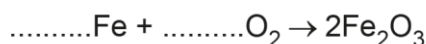
High scoring candidates were completely familiar with the term 'electron shell' and scored well. 'Cells' was also seen quite frequently from candidates who had obviously come across the term but couldn't quite remember it.

Question 8 (a) (i)

8 This question is about transition metals.

(a) Iron reacts with oxygen to form iron oxide, Fe_2O_3 .

(i) Complete the **balanced symbol** equation for the formation of Fe_2O_3 .



[2]

This question produced a useful level of differentiation, with many candidates working out the number of O_2 molecules and the high scoring also calculating the number for the Fe.

Question 8 (a) (ii)

(ii) What is the symbol for the positive ion in Fe_2O_3 ?

Tick (✓) **one** box.

Fe^+

☐

Fe^{2+}

☐

Fe^{3+}

☐

Fe_2^+

☐

[1]

This was not at all well-known but, most importantly, the majority of candidates still attempted the question. The most common choice was Fe^{2+} .

Question 8 (b)

(b) The table shows some information about three metals.

	Melting Point (°C)	Density (g/cm ³)	Reaction with cold water
Metal 1	1064	19.3	No reaction
Metal 2	98	0.97	Bubbles observed
Metal 3	660	2.7	Bubbles observed

Which metal is a transition metal?

Use the data from the table to explain your answer.

Metal

Explanation

.....

.....

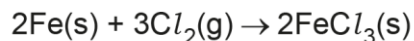
.....

[3]

This question was well answered, with the many candidates scoring all 3 marks.

Question 8 (c)

(c) The equation shows the reaction between iron and chlorine to form iron chloride.



A scientist reacts 2.0 g of iron with excess chlorine to form 4.4 g of iron chloride.

Calculate the percentage yield of iron chloride.

Use:

- percentage yield = $\frac{\text{actual yield} \times 100}{\text{theoretical yield}}$
- theoretical yield = 5.8 g.

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

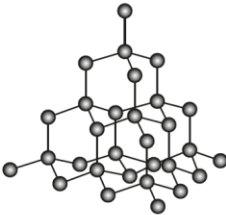
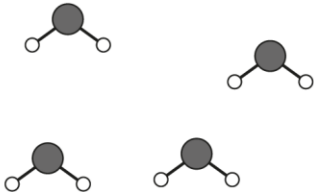
Percentage yield = % **[3]**

While high scoring candidates completed the calculation successfully, it was good that the majority who did not get the right answer still gave enough of their working for examiners to be able to award partial credit.

Question 9 (a) (i)

9

(a) The table shows some information about diamond and water.

	Diamond	Water
Diagram of structure		
Type of structure	Giant structure	Simple molecule
Melting point (°C)	Around 4000	0
Boiling point (°C)	Around 4000	100

- (i) The information in the table shows that simple molecules have weak intermolecular forces between molecules.

Explain why.

.....

.....

.....

..... [2]

High scoring candidates were able to point to the boiling point of water as being an obvious indicator but had much more of a problem discussing the energy needed to overcome those forces. Some candidates interpreted a melting point of 0 as 'no melting point'.

Question 9 (a) (ii)

(ii) Describe the nature and arrangement of chemical bonds in diamond.

.....

.....

.....

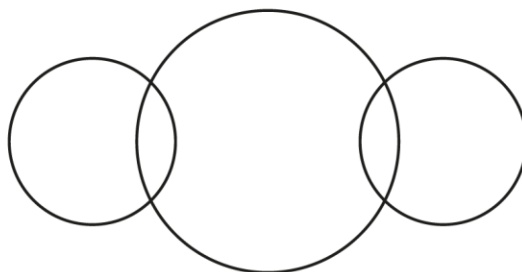
..... [2]

The question had two components, the nature of the chemical bonds and their arrangement. Having been exposed to the term 'intermolecular forces' in the previous question, very few realised that the forces inside the diamond are NOT intermolecular forces but covalent bonds.

Question 9 (a) (iii)

(iii) **Complete** the dot and cross diagram for water.

Atomic numbers: H = 1 O = 8



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[2]

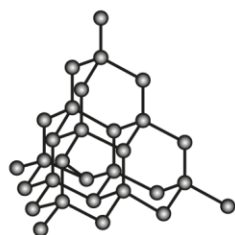
High scoring candidates completed this question successfully, and many others were able to gain partial credit. Many candidates thought the smaller circles represented oxygen atoms and the single larger circle represented hydrogen.

Question 9 (b) (i)

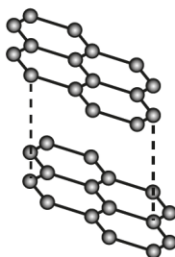
(b) Diamond and graphite are different forms of carbon.

Fig. 9.1 shows their structures.

Fig. 9.1



Diamond



Graphite

(i) Graphite is a good conductor of electricity.

Use the structures to explain why.

.....

.....

.....

.....

.....

..... [2]

Many candidates identified the gap between the sheets of graphite as being important, and high scoring candidates went on to refer to delocalised electrons.

Question 9 (b) (ii)

(ii) Glass can be cut by diamond but not by graphite.

Use the structures to explain why.

.....

.....

.....

.....

.....

..... [2]

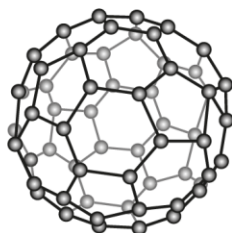
There were many references to 'strong' bonds between molecules and of intermolecular forces inside diamond. Graphite was often described as fragile and there were almost no references to the layers sliding across each other.

Question 9 (c) (i)

(c) Buckminsterfullerene is a nanoparticle made of 60 carbon atoms.

Fig. 9.2 shows the structure of Buckminsterfullerene.

Fig. 9.2



(i) Buckminsterfullerene has a diameter of 1 nm.

What is its diameter in m?

Put a ring around the correct option.

1×10^{10}

1×10^9

1

1×10^{-9}

1×10^{-10}

[1]

Many answers went for the extreme values, which showed sensible thinking in the case of 10^{-10} , but illuminated an alarming misunderstanding of the significance of the positive or negative power symbol in 10^{10} .

Question 9 (c) (ii)

(ii) Buckminsterfullerene is used in medicine to carry drugs into the body.

Describe **two** properties of buckminsterfullerene that make it able to carry drugs into the body.

1

2

[2]

Candidates found this a difficult question to answer clearly, and there were many answers which showed this.

Question 10 (a)

10 Fertilisers are used to increase the growth of plants.

They are added to soil to provide essential plant nutrient elements.

(a) Nitrogen is one essential plant nutrient element.

Name **two other** essential plant nutrient elements.

1

2

[2]

Most candidates found it difficult to transfer their understanding of chemical elements over to the real-world context of agriculture and fertilisers, and suggested sunlight, water, and air.

Question 10 (b) (i)

(b)

(i) State **one** disadvantage of the over-use of synthetic fertilisers.

.....

..... [1]

Some of the high scoring candidates discussed water courses and eutrophication, but there were many answers along the lines of 'it damages the plants' which were not detailed enough to gain credit. A fairly rare answer given was 'it's not natural'.

Question 10 (b) (ii)

(ii) Suggest why farmers still use synthetic fertilisers despite their disadvantages.

.....

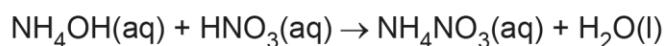
..... [1]

The answers to this question tended to be much better.

Question 10 (c)

(c) An example of a synthetic fertiliser is ammonium nitrate, NH_4NO_3 .

Ammonium nitrate is produced when ammonium hydroxide, NH_4OH , reacts with nitric acid, HNO_3 .



The relative formula masses for the reactants and products are shown in the table.

	NH_4OH	HNO_3	NH_4NO_3	H_2O
Relative formula mass	35.0	63.0	80.0	18.0

Calculate the atom economy for the formation of NH_4NO_3 .

Use the equation:

$$\text{atom economy} = \frac{\text{mass of atoms in desired product}}{\text{total mass of atoms in reactants}} \times 100\%$$

Give your answer to 1 decimal place.

Atom economy = % **[4]**

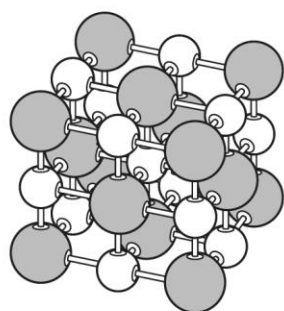
While few got complete credit for this question, most of the others got a least partial credit by showing their working.

Question 11 (a) (i)

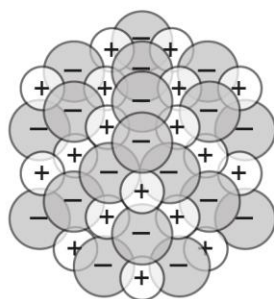
11 Sodium chloride is an ionic compound.

(a) Fig. 11.1 shows three models of the arrangement of ions in sodium chloride.

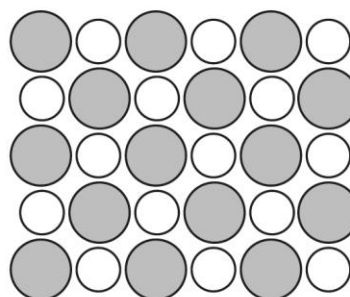
Fig. 11.1



Model A



Model B



Model C

(i) Describe the attraction between ions in sodium chloride.

.....

.....

.....

..... [2]

Candidates who scored well understood that the attraction is due to ions having opposite charges. However, a significant number of candidates discussed attraction between the wrong sort of particles.

Exemplar 3

..... opposites attract so protons
..... attract electrons and
..... electrons attract protons

Either candidates forgot which sort of particles they were referring to, or the question has exposed a deep misunderstanding about the nature of ions.

Question 11 (a) (ii)

(ii) Which **two** statements about the limitations of the models in **Fig. 11.1** are **true**?

Tick (✓) **two** boxes.

Model A does **not** show the relative sizes of the ions.

☐

Model C does **not** show the 3-D arrangement of ions.

☐

None of the models show that sodium chloride is a compound containing two elements.

☐

Only one model shows that a chloride ion is an anion.

☐

[2]

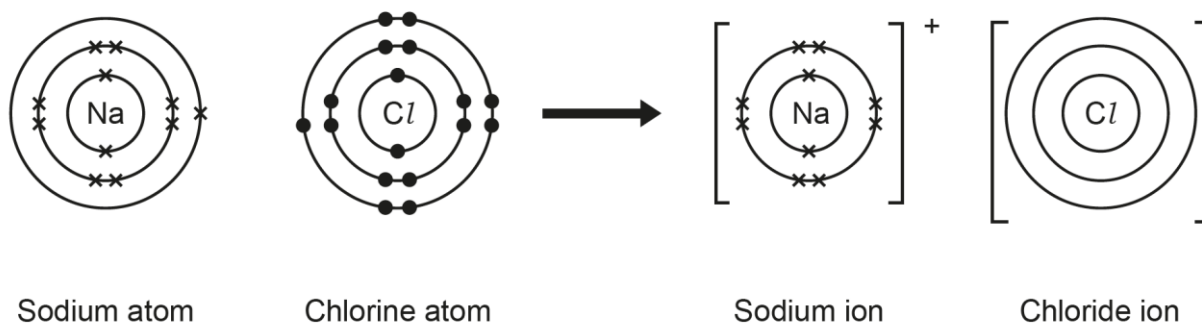
This question was well attempted, with most candidates getting at least 1 of the marks for the second of the statements.

Question 11 (a) (iii)

(iii) **Fig. 11.2** shows the dot and cross diagram for sodium chloride.

Complete Fig. 11.2 to show the structure and charge of the chloride ion.

Fig. 11.2



[2]

A lot of candidates missed this for some reason. However, it was well attempted by the rest, and many got partial credit for a correct electron configuration and high scoring candidates even gave the charge to the ion.

Question 11 (b)

- (b) How does the arrangement of electrons in atoms of sodium and chlorine relate to their group and period in the Periodic Table?

.....

.....

.....

..... [2]

Many discussed the group number and the number of electrons in the outer shell, and high scoring candidates linked period number to the number of electron shells.

Question 11 (c)

- (c) An atom of sodium has an atomic number of 11 and a mass number of 23.

State the number of protons, neutrons and electrons in a sodium atom.

Number of protons =

Number of neutrons =

Number of electrons =

[2]

Most responses got a least one of the numbers correct. The high scoring candidates calculated all three.

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