GCSE

Combined Science: Trilogy

8464/C/1F Combined Science: Trilogy Chemistry Paper 1F

Report on the exam

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Overview

This paper is one of the six examined components for Combined Science: Trilogy. All of these papers follow a similar structure and test the same assessment objectives.

This paper has 70 marks available to students and is made up of eight questions.

- Approximately 40% of marks assess AO1; 40% of marks assess AO2; and 20% of marks assess AO3.
- Approximately 60% of marks target Low demand and 40% of marks target Standard demand.

Questions 6, 7 and 8 on this paper and questions 1, 2 and 3 on the Higher Tier paper are common. These questions are identical and are targeted at standard demand.

Questions are set at two levels of demand for this paper:

- **Low demand** questions are designed to broadly target grades 1–3.
- **Standard demand** questions are designed to broadly target grades 4–5.

A student's final grade is based on their attainment across all six papers.

Summary of overall performance

The questions that were common with the Higher tier proved quite challenging for students on this tier, particularly question 08, where understanding of types of structure and bonding was very limited.

Students had several opportunities to demonstrate use of correct chemical terminology and understanding of chemical processes (questions 04.3 and 04.6).

Generally, students found application (AO2) questions that required them to write something, rather than multiple-choice, challenging and many of these questions were not well answered (05.4 and 06.2) .

The questions assessing maths skills in this paper (01.6, 01.7, 03.4, 03.5 and graph plotting in question 07.4) were generally answered well, with the exception of some unstructured calculations (05.6 and 06.3).

The questions about practical techniques proved more difficult for many students. Most of the practical questions had the highest 'not attempted rates' in the paper (often in excess of 10%) which may be because of many students' unfamiliarity of the Required Practical Activities. Students need to be more familiar with the Required Practical Activities so that they are able to describe why different steps are taken in these experiments and interpret results (questions 03.3, 07.2, 07.3 and 07.5).

Question 1 (low & standard demand)

01.1 Three-quarters of students could name Group 1 elements as the alkali metals. Halogens was the most common incorrect response.

01.2 Three-quarters of students could estimate the radius of a potassium atom as 0.2 nm. A fifth of students selected 0.2 mm.

01.3 The majority of students knew that the atomic number is the number of protons in an atom. Mass number was the most popular incorrect distractor.

01.4 Two-thirds of students gained both marks. Some students failed to indicate that protons are positively charged: + or +1 was needed for the answer. Phonetic spellings of neutron were credited.

0 1 . 4 **Table 1** shows the name and the relative charge of the particles in a potassium atom.

Table 1

Name of particle	Relative charge
Proton	1
Netron	0
Electron	–1

Complete **Table 1**.

[2 marks]

This response demonstrates a common error in not giving the charge on the proton, but the spelling for neutron is acceptable phonetically so marking point 2 was awarded.

01.5 Students were given the electronic structure of a potassium atom (2,8,8,1) and a diagram showing that a potassium ion has a full outer shell (2,8,8). Nearly two-thirds of students were able to deduce that the ion is formed by losing an electron, which results in the formation of a +1 ion. A quarter of students thought that the ion had a –1 charge.

01.6 Most students were able to correctly predict the melting point of potassium from the trend shown in the bar graph.

01.7 Nearly two-thirds of students knew that relative atomic mass is calculated by multiplying the percentage abundance of each isotope by its mass number and averaging these values for all isotopes. A fifth of students selected the third option.

Question 2 (low & standard demand)

02.1 To help students complete the dot and cross diagram for a methane molecule one shared pair of electrons was drawn in one of the overlap areas. More than half the students correctly added three more shared pairs of electrons. Some gained only 1 mark by either adding just one shared pair or including extra electrons in the outer shells of either the carbon atom or hydrogen atoms.

02.2 Three-quarters of students recognised the structure of diamond. Buckminsterfullerene was the most common incorrect response.

02.3 A diagram to represent part of the structure of graphite was given to show that each carbon atom forms three covalent bonds. Nearly 60% of students answered the question correctly. Approximately equal numbers of students thought that carbon atoms formed either two or four bonds with only a small number choosing one bond.

02.4 Just over 40% of the students knew that (delocalised) electrons carry electrical charge through graphite. Many students incorrectly answered that ions or atoms were the particles responsible or wrote carbon for their answer.

02.5 Half of the students knew that fullerenes are used in electronic components. The other two distractors were equally popular.

02.6 Nearly half of the students scored at least 1 mark. A diagram was included to help students describe the structure of a fullerene. The better responses stated that fullerenes are hollow and have hexagonal rings of carbon atoms, although few stated that each carbon atom forms three covalent bonds.

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0 2 . 6 Describe the structure of the fullerene shown in **Figure 4**.

[2 marks]

a Cylinder Shape ~~It~~ that is made up of hexgons

This answer gave two points from the 'extra information' column of the mark scheme so gave *just* enough information to gain 2 marks.

Question 3 (low & standard demand)

03.1 In an investigation the independent variable is the one that is changed, the dependent variable is the one that is measured, and all other variables must be controlled. If a student investigates the temperature change when different masses of zinc are added to copper sulfate solution the independent variable is the mass of zinc and the dependent variable is the temperature change. Just under half of the students answered this correctly. Control (variable) was a slightly more common incorrect response than dependent (variable).

03.2 A word equation was provided to help students identify that the salt zinc sulfate is produced when zinc reacts with copper sulfate solution. A quarter of students gave the correct answer.

03.3 Students found this question challenging. When a question asks for observations students should be encouraged to think 'before', 'during' and 'after'. In the reaction between zinc and copper sulfate solution, zinc is replaced by brown/orange copper solid and the blue colour of the copper sulfate solution fades as colourless zinc sulfate is produced. The colours are not required in the specification, hence the allow statements where there is just reference to the solution/zinc changing colour. 'Colour change' is too vague to gain credit as it does not refer to either the zinc solid or the copper sulfate solution.

The equation for the reaction was provided to help and, although it does not contain any gaseous products, many students gave 'bubbles' or 'fizzing' as an observation.

0 3 . 3 The temperature of the solution increases when zinc reacts with copper sulfate solution.

Give **two** other observations that can be made when zinc reacts with copper sulfate solution.

[2 marks]

1 fizzing

2 colour change

This student did not gain any credit as 'colour change' on its own is insufficient (it could be referring to either zinc or the solution).

03.4 The temperature shown on the diagram of the thermometer scale showed 36 °C. Most students read this correctly and then subtracted the starting temperature to give a temperature increase of 15 °C. A number of students did not use the temperature scale correctly and did not score marking point 1 but could access marking point 2 for a correct subtraction from their highest temperature.

03.5 The calculation of the mean temperature increase was correctly carried out by nearly three-quarters of students. Most students achieved either 2 or 0 marks.

Table 4

Mass of zinc in grams	Temperature increase in °C			
	Experiment 1	Experiment 2	Experiment 3	**Mean**
1.0	7.8	7.3	7.7	**B**
2.0	13.1	13.8	13.3	13.4
3.0	20.4	12.9	20.2	20.3

0 3 . 5 Calculate value **B** in **Table 4**.

[2 marks]

7.8 + 7.3 + 7.7 = 17.66666667

B = 17.6 °C

This student did not gain any credit. They divided only the last number (7.7) by 3, then added, rather than dividing the sum of all three numbers (ie 22.8) by 3.

03.6 The range of results is the 'minimum value to the maximum value'. In the data set the lowest value is 13.1 °C and the highest value is 13.8 °C. 60% of students gained this mark.

03.7 More than half of students correctly identified the anomalous result as 12.9 °C. Reasons why this result is anomalous were not well expressed, however: this result is *much* lower than the other two results (20.4 °C and 20.2 °C).

Alternative answers giving a reason why the result is anomalous such as ‘used less than 3 g zinc’, ‘used more than 50 cm^3 of copper sulfate (solution)’ or ‘the mixture was not stirred’ were much less common.

0 3 . 7 One of the results for **3.0 g** of zinc is anomalous.

Which result is anomalous?

Suggest **one** reason why this result is anomalous.

[2 marks]

Anomalous result experiment 2

Reason this is because it has a lower (decreased) result compared to all the others that were tested.

This student scored the first marking point. The reason is insufficient as they needed to state that this result was *much* lower, rather than just lower.

Question 4 (low demand)

04.1 Many students were able to identify this method as chromatography, though 16% of students did not attempt this question. Students should ensure they are familiar with the rubric of the question paper; after each question the number of marks is shown in square brackets before the area where responses are recorded. Common incorrect responses tended to describe the process with terms such as colour separation, separating ink or the dye experiment.

04.2 Around two-thirds of students were able to identify this method as filtration. 12% of students did not attempt this question. Those who only named the apparatus (eg a funnel) did not answer the question and gained no credit.

04.3 Students found it difficult to explain why solid C separated from the mixture of C and D. 11% of students did not attempt this question. Many incorrectly focussed their answers on how filtration works and described that large particles get trapped by the paper. They needed to answer in terms of solubility of the substances.

0 4 . 3 Explain why solid **C** separated from the mixture of **C** and **D**.

Use **Figure 8**.

[2 marks]

~~Because it had been.~~
The filter/funnel allowed the solution to run into the beaker, but C stayed in the funnel as it was a solid.

This student gained no credit as they did not explain why the separation occurred.

04.4 Fractional distillation is the method used to separate a mixture of liquids; distillation was accepted. Around a third of students were able to identify this method although many referred to processes occurring in the method such as evaporation or condensation. 15% of students did not attempt this question.

04.5 More than two-thirds of students were able to deduce that liquid G collected first as it has the lowest boiling point. Approximately a quarter of students selected 100 °C as their answer, a value they recognise as the boiling point of water.

04.6 Condensing and evaporating were well known and most students gained 2 marks.

04.7 Just over half of students were able to deduce that the temperature of the water leaving the condenser is higher than the temperature of the water entering the condenser. 30% of students thought that the temperature of the water leaving the condenser is lower.

Question 5 (low demand)

05.1 Just over two thirds of students knew that hydrogen gas is produced when a metal reacts with an acid. A quarter of students selected the distractor nitrogen.

05.2 Nearly two-thirds of students knew molten magnesium chloride is a liquid, which is represented by the state symbol (l). A quarter of students incorrectly selected (g) as the state symbol.

05.3 10% of students gained both marks and students were awarded 1 mark if both elements were correct but reversed. Chlor*ide* is not creditworthy although was a common response.

Many students wrote the formula of the ions that were attracted to the electrodes rather than the element that is discharged. Nearly 20% of students did not attempt this question.

05.4 More than half of students gained 2 or 3 marks for correctly deducing the order of reactivity, with magnesium being the most reactive and copper the least reactive and giving one or two reasons. Students were able to give a reason associated with each metal eg iron only reacts with copper chloride solution or copper does not react.

Common incorrect responses included magnesium reacts with both metals (rather than both metal chloride solutions) or reasons which were not clearly linked to a metal (see example below).

0 5 . 4 What is the order of reactivity for copper, magnesium and iron?

Give **two** reasons for your answer.

Use **Table 6**.

[3 marks]

Most reactive magnesium

Least reactive copper

Reason 1 more reactions

Reason 2 no reactions

This student gained the first marking point. When giving reasons students must make it clear what they are referring to. Here 'more reactions' and 'no reactions' are not creditworthy as they do not specifically refer to a metal.

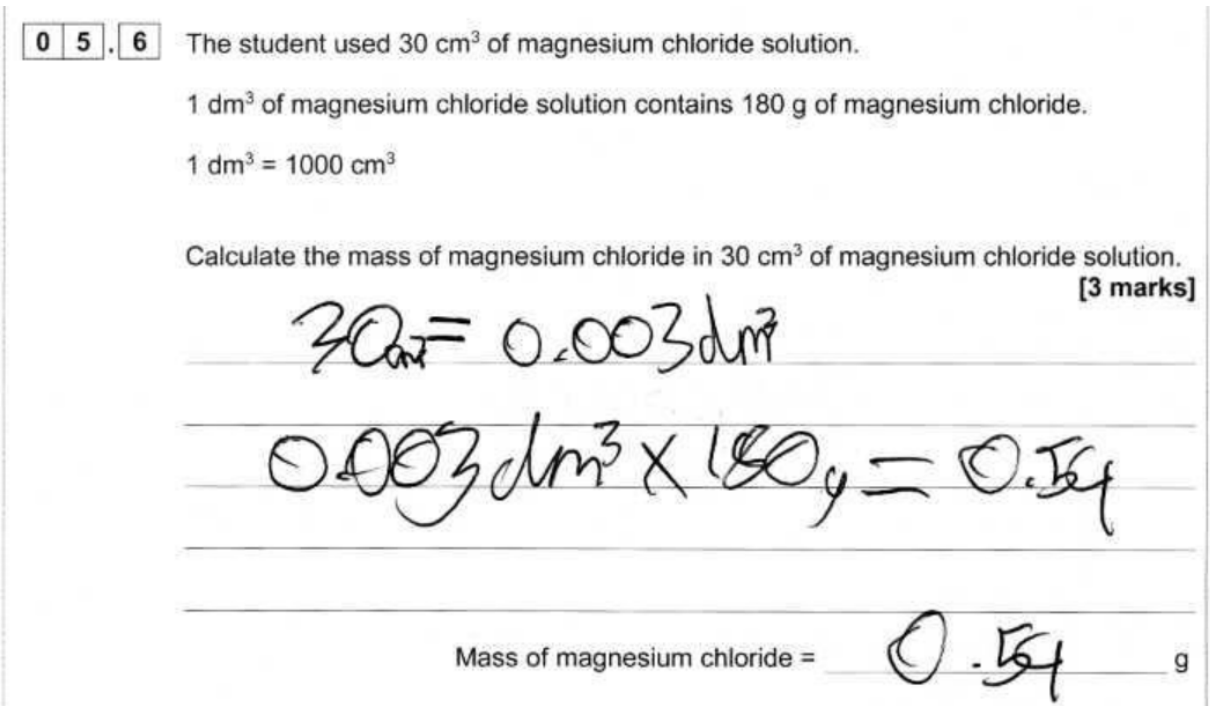
05.5 The law of conservation of mass states that the mass of reactants equals the mass of products. In this question a third of students correctly evaluated that the mass of iron oxide that reacts with 0.72 g of magnesium.

Common incorrect responses were 1.67 (multiplying 0.72 by 2.32) together with 3.2 and 0.31 (evaluated by dividing 2.32 by 0.72 or 0.72 by 2.32 respectively).

05.6 This question required a unit conversion as data is given in dm^3 and needed to be converted to cm^3. This conversion factor was given to lower the demand of the question.

Nearly 30% of students gained all 3 marks. Approximately 10% of students gained 2 marks usually for either not using the conversion factor, for multiplying rather than dividing by 1000 or for using an incorrect factor (eg dividing by 100 rather than 1000). A further 10% of students who gained 1 mark usually calculated the volume correctly in dm^3 but then did not multiply their answer by 180 g or used method 3 in the mark scheme and calculated the ratio of volume as 33.3 but then incorrectly multiplied this by 180 g.

17% of students did not attempt this question.


0 5 . 6 The student used 30 cm^3 of magnesium chloride solution.

1 dm^3 of magnesium chloride solution contains 180 g of magnesium chloride.

1 dm^3 = 1000 cm^3

Calculate the mass of magnesium chloride in 30 cm^3 of magnesium chloride solution.

[3 marks]

30cm = 0.003dm³

0.003dm³ × 180g = 0.54

Mass of magnesium chloride = 0.54 g

This student scores 2 marks. They have used method 1 and made an error with the unit conversion. The student gains marking point 2 for multiplying their incorrect volume by 180 g. This expression is then correctly evaluated as 0.54 g for marking point 3.

Question 6 (standard demand)

06.1 Few students gained 2 marks on the although more than half gained 1 mark. The graph showed that the mass of copper produced each year slowly increased from 1900 to 1930 and then rapidly increased until 2010. Students were asked to give two conclusions, so statements that merely quoted numerical values and years from the graph or made predictions of the future were insufficient.

Non-creditworthy responses referred to use or demand of copper or involved incorrect readings, for example ‘rapid increase from 1950’ (rather than from 1925 to 1930) was common.

06.2 Students should know that metals are soft so are mixed with other metals to make alloys, which are harder. A diagram representing the structures of pure copper and of an alloy of copper and zinc was given that showed larger zinc atoms disrupting the layers of atoms in the alloy, thus the layers of atoms cannot easily slide. Some students did not read the question carefully and talked about copper rather than the alloy.

15% of students gained 1 mark or more and few students achieved all 3 marks. Those who gained a mark usually referred to the difference in the sizes of the atoms. Many answers attributed hardness of the alloy to some form of bonding between copper and zinc.

06.3 In this calculation students were told that the alloy contains 13.5% zinc by mass and were asked to calculate the mass of copper in the alloy. As always there are a number of approaches students took and those who showed their working often gained credit even after making errors. In the calculation working with an accompanying percentage sign, such as 13.5% or 86.5% are considered to be equivalent to 13.5 ÷ 100 and 86.5 ÷ 100 respectively eg 13.5% of 5.25 gains marking point 1 in the second method.

More than half of students scored at least 1 mark and nearly a fifth gained all 4. 16% of students did not attempt this question. Those who gained 1 mark achieved this by either determining the percentage of copper as 86.5% (mark scheme method one) or for a calculation that used the values in the question (5.25 and 13.5) if the expression was evaluated correctly and the answer was rounded to 3 significant figures eg 13.5 ÷ 5.25 = 2.57 (marking point 4 in either method one or method two).

0 6 . 3 A 5.25 g sample of an alloy of copper and zinc contains 13.5% zinc by mass.

Calculate the mass of **copper** in the 5.25 g sample.

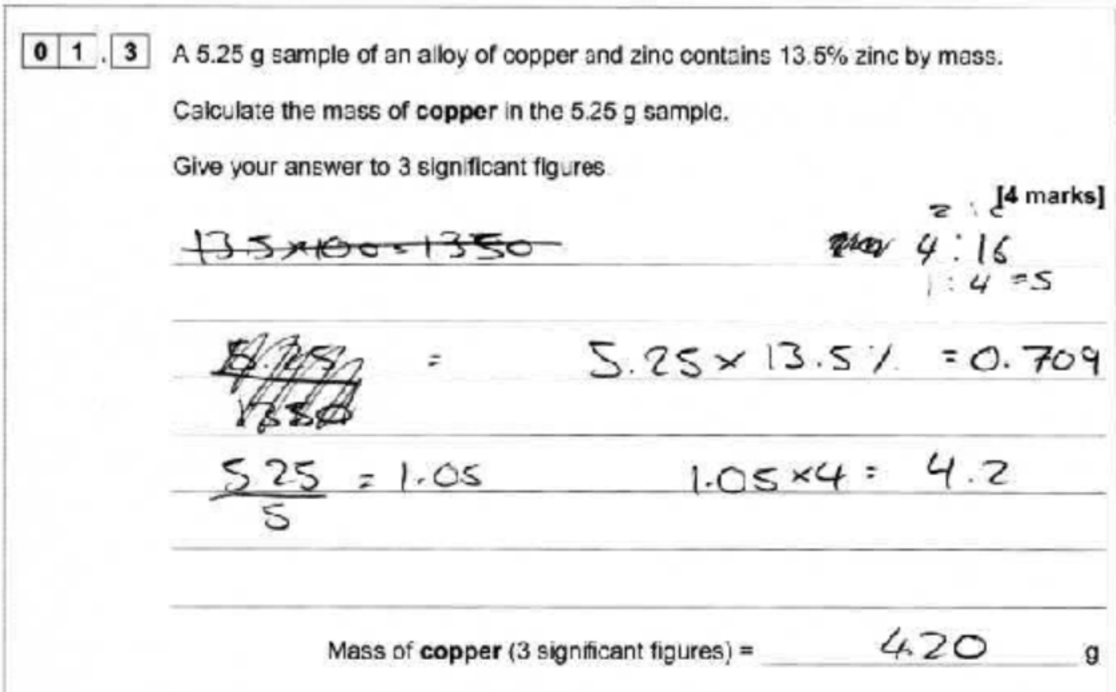
Give your answer to 3 significant figures.

[4 marks]

13.5% of 5.25 = 0.70875

0.709

This response (from a Foundation tier paper) used mark scheme method 2. The student correctly determined the mass of zinc to 3 significant figures but did not subtract this from the mass of the sample. They achieved marking points 1, 2 and 4 so scored 3 of the 4 marks.



0 1 . 3 A 5.25 g sample of an alloy of copper and zinc contains 13.5% zinc by mass.

Calculate the mass of **copper** in the 5.25 g sample.

Give your answer to 3 significant figures

[4 marks]

~~135 × 100 = 1350~~ 4 : 16

1 : 4 = 5

= 5.25 × 13.5% = 0.709

$\frac{5.25}{5}$ = 1.05 1.05 × 4 = 4.2

Mass of **copper** (3 significant figures) = 4.20 g

This response (from a Higher tier paper) has several different methods in the answer box. Initially the student might gain marking points 1, 2 and 4 from method 2 (as the previous example did). However, the student then gives a totally different method which gives the answer on the answer line and this is the one that takes precedence so the method attached to this is the one that is marked. Although 4.20 is correctly rounded to 3 significant figures it does not come from a calculation using all values in the question (ie 13.5% has not been used) so gains no credit.

Question 7 (standard demand)

07.1 By selecting H_2SO_4 more than half of students answered correctly. HCl was the most common incorrect response.

07.2 Excess copper carbonate is used to ensure all the acid reacts. Very few students stated this.

Common incorrect responses included that copper carbonate needs to dissolve, to make sure all the copper carbonate reacted (rather than the acid), to get the most product, so everything had reacted or in terms of the rate of reaction. In responses ‘it’ refers to copper carbonate.

0 7 . 2 Why is excess copper carbonate used in **stage 1**?

[1 mark]

So that we know we have added enough for ~~the~~ it to have fully reacted.

0 2 . 2 Why is excess copper carbonate used in **stage 1**?

[1 mark]

so the acid is fully neutralised or reacted

The first response is not creditworthy as ‘it’ refers to the copper carbonate. The second response (from a Higher tier paper) gains a mark as ‘acid is the limiting reactant’ or ‘to fully neutralise the acid’ are equivalent to all the acid reacting.

07.3 The method would work if filtration was carried out immediately before or after heating so was ignored in any response. Few students gained both marks.

> **0 7 . 3** Beaker **N** contained copper sulfate solution.
>
> Describe how the student could produce copper sulfate crystals from the copper sulfate solution in beaker **N**.
>
> **[2 marks]**
>
> The Student Could heat it with a bunsen burner ~~until~~ until it boils and then pour it out on a tray
>
> **0 2 . 3** Beaker **N** contained copper sulfate solution.
>
> Describe how the student could produce copper sulfate crystals from the copper sulfate solution in beaker **N**.
>
> **[2 marks]**
>
> By filtering it and then heating the solution up, leaving to cool for 24hours and patting it dry as crystals have formed.
>
> The first response gains the first mark but there is insufficient detail to gain the second mark (leave to cool/crystallise). In the second response (from a Higher tier paper) filtering is ignored and 2 marks are awarded.

07.4 At low demand all points would lie exactly on a 'line of best fit' whereas at standard demand there will be points either side of the line so students need to 'make a decision' when drawing their line. The line of best fit did not need to extend beyond the five points, although extrapolations were allowed and many included the origin (0,0). If students plotted any point(s) incorrectly they could still gain the mark for 'their' line of best fit. A large number of students did not use a ruler and as such were unable to draw an acceptable straight line. Just over a third of students gained all 3 marks and a similar number 2 marks.

07.5 Investigation of mass changes using various apparatus is an opportunity for skill development in the specification, eg thermal decompositions of metal carbonates. This was not well answered on either tier of the paper. Many students incorrectly referred to evaporation or gave answers such as 'some of it escapes', which is insufficient. Some recognised that a gas is made but needed to say that the gas escapes to explain the decrease in mass.

Question 8 (standard demand)

08 This was an 'extended response' style of question. Such questions are marked holistically. There are overall generic descriptions for the two levels of response at the top of the mark scheme, giving a hierarchy of response. Within each level there are 3 marks.

Students were asked to compare the structure and bonding of sodium chloride and oxygen; diagrams that represent the structures were given. The indicative content was not an exhaustive list and examiners used professional judgement with other content.

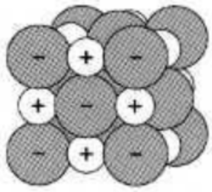
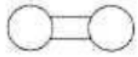
At Level 1, students needed to identify some relevant features of each substance and note some differences. To enter Level 2 students needed to clearly show the ways in which the structure and bonding of the two substances are similar/different and note the magnitude of the similarity/difference. Examples of magnitude include strong (bond), weak (forces), giant (structure of ions), small (molecule) and two or one (elements). To access Level 2 a minimum of four comments on the relevant features were required, at least one of which must include a comparison, and a reference to magnitude had to have been made. To gain 5 or 6 marks there needed to be a minimum of two comparative statements, a reference to magnitude and statements referring to the structures.

Most students wrote a great deal but said little that was creditworthy. A quarter of students gained 1 mark or more and there were very few Level 2 answers. Attempts were made at comparisons but what they were comparing was incorrect chemistry. Indications of magnitude were rarely seen. Many students wrote about the properties of sodium chloride and oxygen, in particular referring to their melting and boiling points and electrical conductivity, or they referred to the number of protons, neutrons and electrons in atoms of each of the elements involved; none of which answered the question.

Most students gained their marks from stating that sodium chloride is a compound of two elements and oxygen is an element made up of atoms. There were very few correct descriptions of the type of bonding. Many responses described the ions in sodium chloride as protons and electrons, charged atoms or simply positive and negative charges. 'Sodium chloride is an ionic bond' was a common error. Similarly, in the case of oxygen many students stated that 'it is a covalent bond' and is 'made up of two molecules'. Students tended to describe the bonding in sodium chloride in more detail than that for oxygen. Many explained in detail how sodium transfers its outer electron to chlorine but lost the credit by saying that it was gained by chlor*ide*.

0 8 **Table 8** shows diagrams which represent the structures of two substances.

Table 8

Substance	Structure
Sodium chloride NaCl metal + non	
Oxygen O_2 non	

Compare the structure and bonding of sodium chloride and oxygen.

[6 marks]

Sodium chloride is ionic bonding which is between a metal and a non metal. They use electrostatic forces to transfer electrons. They create giant structures and have a high melting point. ①

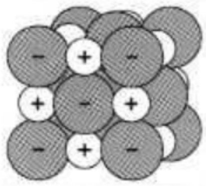
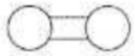
Oxygen is a non metal which is used for covalent bonding as its for two non metals. They have strong covalent bonds but have weak intermelecular forces. They can conduct electricity.

① They can also conduct electricity but only when molten

The response (from a Foundation tier paper) includes references to magnitude (*weak* intermolecular forces and *strong* bonds) and sufficient indicative content to access Level 2 (bullet points 4, 10, 11, 15). However, there is no comparison (simply a list of statements referring to sodium chloride and then a list for oxygen), so the response does not meet the Level 2 descriptor. They have identified a number of relevant features, so the response was awarded 3 marks, top of Level 1.

0 8 **Table 8** shows diagrams which represent the structures of two substances.

Table 8

Substance	Structure
Sodium chloride NaCl	
Oxygen O_2	

Compare the structure and bonding of sodium chloride and oxygen.

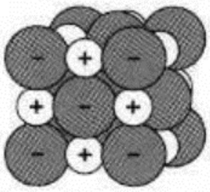
[6 marks]

Oxygen is an element and Sodium Chloride is a compound which is arrangd in a lattice Structure with Positive and negative [illegible] ions. ~~oxygen has 2~~ Sodium Chloride has ~~strong~~ Ionic bonds.

The response (also from a Foundation tier paper) is set out as a comparison with sufficient indicative content to access Level 2 (bullet points 5, 3, 9 and 8) but there is no reference to magnitude (strong/weak, giant/small or one/two element(s)). Therefore, similarly to the previous example, the response does not meet the Level 2 descriptor. It was awarded 3 marks.

0 3 **Table 2** shows diagrams which represent the structures of two substances.

Table 2

Substance	Structure
Sodium chloride NaCl	
Oxygen O_2	

Ionic

Covalent

Compare the structure and bonding of sodium chloride and oxygen.

[6 marks]

In NaCl, ionic bonding occurs. Sodium will transfer its outer electron to chlorine to form a positive ion and when chlorine receives this transferred electron, it will form a 1^- ion. Due to the ions being oppositely charged. Strong electrostatic forces holds them together. In O_2 however, covalent bonding occurs as it is non metal and O_2 will form a double covalent bond as it shares 2 electrons from their outer shell with each other in order to get a full outer shell and make it stable.

This response (from a Higher tier paper) is set out as a comparison (use of 'however' in line 8) with sufficient indicative content to access Level 2 (bullet points 8, 9, 10, 11, 13 and 14). Bullet points 1 and 2 are mentioned for oxygen but not sodium chloride. In addition to the comparison a reference to magnitude (*strong* electrostatic forces) is included so 4 marks are awarded. Statement(s) referring to the *structure* of sodium chloride and/or oxygen were required for 5+ marks

Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

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