



GCSE

Combined Science: Synergy

8465/3F Paper 3 Physical Sciences Foundation Tier

Report on the examination

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General comments

There were 10 questions on this paper. Questions 1, 4, 6, 7, 9 and 10 were chemistry content, and questions 2, 3, 5 and 8 were physics content. The questions are designed to increase from low demand to standard demand through the paper.

This paper also contained items targeting mathematical and practical skills. Students should be advised to clearly show the method of their working when completing calculations, even simple ones that are easily done on a calculator. It can be difficult for examiners to credit responses if they cannot clearly follow the method the student has used. Access to the Physics Equations Sheet seemed to benefit many students. Many students seemed unfamiliar with laboratory techniques, equipment and methods. Two Required Practical Activities were targeted in this paper, RPA17 and RPA21.

In general students should be reminded to use correct technical language in responses and to take care to write formulae accurately. Ideally students should use full sentences when writing a description or an explanation. Whilst diagrams can sometimes support a written response, they are unlikely to be creditworthy without being clearly labelled.

Levels of 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, however, is based on their attainment across the qualification as a whole, not just on questions that may have been targeted at the level at which they are working.

Questions 8, 9 and 10 are common with questions 1, 2 and 3 on the higher tier. These questions are identical with each other and are targeted at standard demand.

Question 1 (low and standard demand)

- 01.1** About three fifths of students identified calcium as the metal. Carbon and silicon were the most popular incorrect answers chosen.
- 01.2** Approximately a quarter of students identified chlorine as the halogen. Students found this multiple-choice question difficult, with over a half of students choosing helium instead.
- 01.3** Students found this multiple-choice question difficult, and less than a fifth of students identified that fullerenes are formed from carbon. Silicon was the most popular

response. However, the relatively even distribution of responses to this item suggests that fullerenes were unfamiliar to most students.

- 01.4** Students found this standard demand multiple choice question difficult, with just under a third of students identifying helium as the element with a stable arrangement of electrons. Carbon and calcium were the most common incorrect answers chosen.
- 01.5** Just over a third of students identified that carbon and silicon had atoms with the same number of electrons in their outer shell. Some students attempted to work out the number of electrons in the outer shell of various elements using data from the periodic table. This was unnecessary and showed a lack of understanding of groups in the periodic table. A very small number of students chose other pairs of elements from groups on the periodic table. However, as these pairs of elements were not present on the figure on the question paper, they were not creditworthy. About one in thirteen students did not attempt the question.
- 01.6** Just over a half of students correctly completed the electronic structure of lithium.
- 01.7** Just over a half of students correctly identified rubidium as the most reactive Group 1 element on the figure on the question paper. A small proportion of students identified francium, but as this was not on the figure, this was not creditworthy.
- 01.8** Just under two thirds of students gave a correct observation, and just over a fifth of students gave two observations. The most popular response was bubbles, or equivalent descriptions of this such as fizzing. However, simply stating that a gas was produced was insufficient for the mark, as that is not an observation but a deduction from an observation. Other popular creditworthy responses included sodium floating or getting smaller. Credit was not given for any observation requiring extra equipment, such as a thermometer or an indicator, for references to sound, or for the idea of flames or explosions as these are more typical laboratory observations of Group 1 elements with a higher reactivity.
- 01.9** Slightly less than half of students identified sodium hydroxide solution as the alkaline solution produced when sodium reacts with water.

Question 2 (low demand)

- 02.1** Just under three quarters of students correctly identified the portion of the graph where the car was travelling at constant speed. A third of students went on to give a creditworthy reason for their correct response. Some students referred to the line going straight up, which could not be credited as the meaning is ambiguous. A few students confused this distance-time graph with a speed-time graph and mentioned speed increasing at a constant rate.
- 02.2** A third of students correctly identified that the driving force was the same size as air resistance. Only a very few students gave a creditworthy reason for their correct response, with many students simply re-stating that the two forces were the same size.

The most popular incorrect response was that the driving force was greater, with many students asserting that it must be greater to keep the car moving forward.

- 02.3** Four fifths of students correctly stated that when the driver applies the brakes, the friction in the brakes increases.
- 02.4** Over two thirds of students correctly stated that when the parachute opens, the air resistance acting on the parachute increases.
- 02.5** Three quarters of students correctly stated that applying the brakes and opening the parachute causes the velocity of the car to decrease.
- 02.6** Students found this multiple-choice question easy, with over two thirds identifying that when a car has a very large deceleration, the driver may lose control of the car.

Question 3 (low demand)

- 03.1** Students found this multiple-choice question easy, with three quarters identifying that four 1.5 V cells are used to make a 6.0 V battery.
- 03.2** Over a half of students got this $V = IR$ calculation completely correct. A fifth of students scored one mark due to incorrect evaluation. This was typically a power of ten error, with $3.0 / 2000 = 1.5$ V being a common response. One in twelve students did not attempt the item.
- 03.3** Students found this multiple-choice question difficult. Three quarters did not realise that total potential difference across components in a series circuit and across the battery is the same.
- 03.4** Students found this multiple-choice question difficult, with only a quarter of students choosing the correct expression of 6.0 V – 3.0 V. Over a half of students chose $\frac{6.0 \text{ V}}{3.0 \text{ V}}$ as the method to calculate potential difference across the resistor.
- 03.5** About four fifths of students correctly determined the resistance of the LDR at a particular light intensity from a graph of LDR resistance against light intensity.
- 03.6** Roughly four fifths of students correctly identified one conclusion, and about forty percent of students identified two conclusions. Resistance decreasing as light intensity increases was correctly identified by nearly three quarters of students, with resistance and light intensity having a non-linear relationship identified by just over half of students. The incorrect ideas of a positive correlation or a directly proportional relationship between resistance and light intensity were the most popular distractors.
- 03.7** Over a half of students correctly identified that an LDR would be needed in a circuit to switch lights on at night.

Question 4 (low demand)

- 04.1** About a third of students correctly identified the type of bonding in both chlorine and lithium chloride. Around half of the students identified the type of bonding in one substance, most commonly covalent bonding in chlorine. However, choosing covalent bonding for chlorine and metallic bonding for lithium chloride created a symmetrical pattern of lines, so this may not reflect a difference in the understanding of different types of bonding.
- 04.2** Students found this multiple-choice question easy, with over two thirds of students correctly identifying that hydrochloric acid reacts to produce a chloride.
- 04.3** Many students found this multiple-choice question very difficult, with under a fifth recognising that lithium chloride is a salt. About a third of students thought that lithium chloride was an acid, and approximately half thought that it was an alkali.
- 04.4** Students struggled with this item, with a fifth not attempting to answer. Only about one in ten students scored both marks, with under a fifth scoring one mark, and about half of students gaining no credit. Common errors included incorrect use of technical language, such as referring to chlorine ions or the positive electrode as the cathode. Confused or ambiguous references to 'they' or 'it' made it difficult to confidently award marks to some responses. Responses referring to Cl^- without explicitly identifying the ions as negative could not be credited with the first mark point.
- 04.5** Nearly two fifths of students identified the types of charge carrier in both the wires and the solution. A slightly smaller number correctly identified at least one type of charge carrier, mostly commonly that charge is carried through the wires by electrons.
- 04.6** Over a quarter of students identified the correct gas test results for both chlorine and hydrogen. Nearly half of students were able to identify a correct gas test result for one gas, most commonly that hydrogen produces a 'pop' sound with a burning splint.
- 04.7** Nearly two thirds of students correctly identified that hydrogen is produced at the negative electrode because it is less reactive than lithium.
- 04.8** To scaffold this low demand item, students were told how many electrons each atom had in its outer shell. Over a quarter of students completed the dot and cross diagram for hydrogen chloride correctly, scoring both marks. Nearly a fifth of students scored one mark, most commonly for placing a pair of electrons in the overlap. Some students could not be awarded any marks as they placed hydrogen's electron outside the overlap as a non-bonding electron. One in six students did not attempt the item.

Question 5 (low and standard demand)

- 05.1** This item proved to be surprisingly difficult. Roughly a third of students who attempted it drew a correct circuit symbol for an ammeter. The most common error was omitting the wires from the symbol. About one in ten students drew a circuit diagram including an ammeter, for which credit could be given if it was labelled. A small number of students appeared unfamiliar with the concept of circuit symbols and instead redrew the ammeter equipment. Over 15% of students did not attempt the item.
- 05.2** Only about a fifth of students scored full marks on this graph. Most students plotted all five points correctly. However, not being able to draw a neat enough point meant that some students could not be awarded both plotting marks. Points where the centre cannot be confidently identified cannot be credited. Students should be encouraged to use a sharp pencil and to draw crosses, not blobs. Most students did not draw a creditworthy curved line of best fit. This was a standard demand mark, with all points falling on the curve. Many students drew a straight line of best fit or simply joined the dots using lines drawn with a ruler. Some students sketched the line or made multiple attempts which results in doubled lines. One in twenty students did not attempt the item.
- 05.3** The majority of students found this multiple-choice question easy. Over two thirds of students identified that using fewer turns of wire on an electromagnet will result in fewer paperclips being picked up.
- 05.4** Over half of students were able to identify one magnetic material, most commonly nickel, but only about one in six students correctly identified both. Cobalt was only identified by roughly a third of students and was a less popular choice than copper or magnesium.
- 05.5** Slightly more than a third of students gave a creditworthy response to this item. Most stated that an electromagnet can be switched off. Some students clearly had the idea but just referred to material being picked up and dropped, which was insufficient. Stating that an electromagnet was stronger was also popular, but few students referred to the variability of strength of the electromagnet. A recurring incorrect response was the suggestion that an electromagnet is easier to recycle or reuse. About one in eight students did not attempt the item.

Question 6 (low and standard demand)

- 06.1** Over three quarters of students were able to identify both pieces of measuring equipment needed, with approximately one in ten students identifying just one piece of equipment correctly.
- 06.2** Only about a third of students successfully added a scale and correctly plotted the bar for lithium chloride, scoring both marks. Just over a fifth of students scored one mark, mostly for adding a suitable scale. About one in ten students tried to plot a bar without

adding a suitable scale first. It is possible that some of these students did not recognise that they had been directed to do so. Most students who attempted plotting a bar without a scale were unsuccessful. More than 10% of students did not attempt the item.

- 06.3** This standard demand item was not attempted by a nearly a fifth of students. However, just over half of the students who did attempt it were able to successfully state that the increase in temperature in the results showed that the process was exothermic.
- 06.4** Whilst about one in ten students did not attempt this calculation of a mean value, most of those who did scored full marks. Some students simply added the results together, whilst others used an incorrect divisor. Students who showed the correct method in their working scored a mark even if the method was separated into two steps.
- 06.5** Slightly less than a third of students correctly identified which label represents the products on the reaction profile. Most students chose the label which actually represents the reactants.
- 06.6** Approximately two thirds of students correctly identified which label represents the activation energy on the reaction profile.
- 06.7** Just under a half of students correctly identified which label represents the overall energy change on the reaction profile. The most popular alternative was the label which actually represents the products.

Question 7 (low and standard demand)

- 07.1** Just over a third of students identified that a displacement reaction happens between copper and silver nitrate. However, the relatively even distribution of responses to this item suggests that reaction types were not well known.
- 07.2** Just over a third of students gave one correct observation, with about one in ten students giving two observations that can be made when copper reacts with silver nitrate solution. Some students described what happened in the chemical reaction rather than what would be observed, which was not creditworthy. Nearly 15% of students did not attempt the question.
- 07.3** Students struggled with this standard demand item, with approximately one in ten students not attempting it and more than three quarters unable to determine a correct order of reactivity for the metals from the information provided.
- 07.4** Nearly three quarters of students correctly stated that the safety precaution the student should use in this practical would be to wear eye protection. Terms such as goggles or safety glasses were considered equivalent responses. Many students suggested gloves, even though gloves are not routinely worn in school chemistry practicals. Generic safety precautions such as tying hair back or lab coats were also not considered creditworthy.

- 07.5** Just under a quarter of students correctly suggested that warming the nitric acid would increase the rate of reaction. Equivalent terms such as speeding the reaction up were accepted, but not that it was more reactive or that the copper oxide dissolved quicker. Nearly a fifth of students did not attempt the item.
- 07.6** Students were asked to write a plan to produce pure copper nitrate crystals from the mixture produced after the initial reaction in a standard salt preparation. This Required Practical Activity method was not well known, with some very confused responses. Over a third of students did not attempt this standard demand item. Of those that did, most did not score highly. Many did not produce sufficient creditworthy material to access Level 1, and only a very small proportion wrote a Level 2 response. Some students did not realise that only the second half of the salt preparation was required and started their responses with a description of how to produce the initial mixture. As this was repeating information given in the method in the question stem, the creditworthy part of most responses was considered to be from the point of filtration onwards, if filtration was mentioned.

Three key steps were required: filtration, heating the filtrate and leaving it to crystallise. All three key steps were needed to access a Level 2 mark. However, very few students did this, omitting one or more key steps in their entirety. Some students omitted filtration and went straight to crystallisation. Many students did not mention heating the filtrate, instead simply leaving it to crystallise. Leaving the solution in a warm place or in sunlight was accepted as a method of heating. However, without some indication of heating, this key step was not met. Some students suggested heating until all the liquid was gone, which indicated that the filtrate was heated to dryness. This would render the final key step invalid, even if the student then attempted to describe crystallisation.

Question 8 (standard demand)

- 08.1** Many students found this multiple-choice question easy. Over two thirds of students successfully used the Physics Equations Sheet to identify the correct equation linking distance, speed and time.
- 08.2** A majority of students correctly calculated the mean speed of the rugby player. About a quarter of students scored zero marks, having incorrectly substituted into the equation. Multiplying the values in the question was the most popular incorrect approach. More than 10% of students did not attempt the calculation.
- 08.3** Students found this multiple-choice question easy. More than 80% of students successfully used the Physics Equations Sheet to identify the correct equation linking acceleration, change in velocity and time.
- 08.4** Very few students scored full marks for this calculation of the deceleration of the rugby player, as most did not convert time from ms to s. However, nearly a half of students scored two marks by substituting into the equation the unconverted value for time and correctly evaluating this. Slightly more than 30% of students did not score any marks,

and multiplying the values in the question was the most popular incorrect approach. Nearly a fifth of students did not attempt the calculation at all.

- 08.5** Students found this multiple-choice question easy. Slightly more than four fifths of students successfully used the Physics Equations Sheet to identify the correct equation linking acceleration, mass and resultant force.
- 08.6** Very few students scored full marks for this calculation of resultant force, as most did not convert mass from g to kg. However, nearly a half of students scored two marks by substituting into the equation the unconverted value for mass and correctly evaluating this. About three in ten students did not score any marks. In this case, dividing the mass by the deceleration was the most popular incorrect approach. A noticeable proportion students did not attempt the question.
- 08.7** Only about one in ten students gave a creditworthy response which included the idea of immediate action being taken to mitigate a player's possible head injury. Students were told that the team doctor was automatically alerted to a deceleration of 540 m/s^2 or more. Some students simply repeated this, but did not suggest what action the doctor might take. Others suggested that a player might seek medical attention but did not indicate when. This did not address the need for a timely response in mitigating head injuries to rugby players. Some students suggested that data could be collected to help rugby players improve their performance or for research purposes. These responses were not creditworthy, as they missed the essential safety feature of the new mouthguard. Some students ignored the data transfer feature altogether and instead focussed on other protective advantages of a mouthguard. These included the advantages of a mouthguard being new, or the protection that wearing a mouthguard would give to teeth. About sixth of students did not attempt the item.

Question 9 (standard demand)

- 09.1** Many students did not understand this item, and only about one in twenty gave a creditworthy response. Most students focussed on describing gold or restating the stem information. Common responses included: gold is pure, an element, not a compound, a metal, a solid, an ore in the Earth's crust. Stating that gold does not form compounds does not explain why. Stating that gold is not very reactive or has low reactivity is not equivalent to gold is unreactive. Some students stated that gold did not react with a specific element such as oxygen. However, this was insufficient for the mark as it does not convey the idea that gold is unreactive in general. About a fifth of students did not attempt the item.
- 09.2** Whilst over 40% of students identified that carbon is the substance oxidised, very few went on to state the reason that this because oxygen is **gained** by carbon in the reaction. Responses such as oxygen reacts with carbon or is added to carbon were insufficient for the mark. Other chemically correct comments in responses were disregarded. More than a fifth of students did not attempt the question.

- 09.3** Only about one in ten students gave a creditworthy response comparing the reactivity of aluminium and carbon. Slightly less than a quarter of students did not attempt the question.
- 09.4** This item was not understood well, with **less than** one in twenty students scoring any marks. This was mostly for stating that energy was required to melt the mixture or the aluminium oxide. Very few scored the second mark, and it was rare for a student to recognise that the production of an electrical current for electrolysis required energy. Many students gave responses referring to the strength of bonding or the need to separate the ions, without considering what this might mean practically. Nearly a third of students did not attempt this item.
- 09.5** Many students struggled with this calculation of a percentage decrease. Slightly less than three in ten students did not attempt the calculation. Approximately half of the students who did attempt it did not produce any creditworthy working, and fewer than 10% achieved full marks. However, some students picked up marks for a correct step, most commonly determining the energy decrease. A majority of students took the main approach on the mark scheme. Some students took the alternative approach, but many only calculated the percentage energy for recycled aluminium. Many correctly rounded an answer from an incorrect calculation and so achieved the final mark. A few students attempted to unnecessarily convert MJ to J and these attempts usually resulted in a power of ten error in the final answer.

Question 10 (standard demand)

- 10.1** Slightly more than 10% of students successfully completed this ratio calculation, including correctly converting either the diameter or the length of the nanotube. However, many students' attempts at conversion were incorrect. Some students tried converting both diameter and length, most commonly by multiplying both by 10^6 . In this case, the correct conversion of length was contradicted by an incorrect conversion of diameter. Incorrect or no conversion still allowed access to the ratio calculation. Some students calculated the ratio of diameter to length, which was not creditworthy. Nearly three in ten did not attempt the calculation.
- 10.2** Most responses to this item demonstrated a substantial lack of knowledge and understanding of the structure and bonding of diamond and graphite. Over a half of responses did not include any creditworthy content. Only about one in six students scored over one mark. Many students simply described the diagrams of diamond and graphite provided, which was usually not creditworthy. Many referred to properties of diamond and graphite, but this was not creditworthy as the question was about structure and bonding. In addition, when attempting to explain these properties, some students demonstrated misunderstandings. A common suggestion was that diamond is harder than graphite because the (covalent) bonds in diamond are stronger than the (covalent) bonds in graphite. A very small number of students wrote good responses which demonstrated a detailed understanding. Directly comparing features of graphite and diamond was required to access Level 2 and only a very small proportion of students did so. Some very good responses could not be awarded full marks due to the presence

of a serious chemical errors. Serious errors included referring to weak covalent bonds, incorrect forms of bonding or an incorrect number of bonds per atom.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the [Results Statistics](#) page of the AQA Website.