GCSE
COMBINED SCIENCE: SYNERGY

8465/4F
Report on the Examination

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General

There were 9 questions on the paper, with questions 8 and 9 being common with the Higher Tier. A wide range of marks were obtained, with good differentiation seen on most questions. However there were a number of questions that were not attempted by a significant number of students.

Students did not always appear to have latched on to the command word in a question. It would benefit students to be made aware of the different command words, and to be encouraged to look for them in questions. So for instance, if asked to 'explain' they 'should make something clear, or state the reasons for something happening'.

The handwriting of some students was very difficult to read

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.

Question 1 (low demand)

01.1 10% of students did not attempt this first question on the paper. Approximately 60% correctly chose hydrogen and carbon as the two elements present in hydrocarbons. Common incorrect answers included carbon dioxide, carbon monoxide and hydrogen oxide or water. Some students realised that hydrocarbons were related to crude oil and wrote down two of the fractions obtained from the fractional distillation of crude oil. A variety of other answers was seen, some such as bromine and copper were elements, others such as salt and hydrochloric acid were not.

01.2 Nearly one third of students correctly identified plankton as the answer. Other responses were spread fairly evenly between the other three options, with 'metals' gaining slightly more choices.

01.3 Around two thirds of students correctly identified the process as fractional distillation. 'Combustion' was the next popular choice, followed by 'steam cracking', with few students choosing 'phytomining'.

01.4 The crude oil is heated to evaporate or vaporise the hydrocarbons. Less than 10% of students gained the mark for this. Many described why fractional distillation is carried out, rather than the reason for heating, ie to separate the crude oil into the different fuels. Whilst being true, this had been stated earlier in the question, so was not worthy of credit. Several answers referred to the crude oil melting or turning into a liquid, suggesting a mis-understanding of the state of crude oil. Another answer which was seen several times was to get rid of bacteria or to kill harmful organisms.

01.5 Over 90% students answered this correctly; of the other responses, 'petrol' was the most popular choice.

01.6 Around 8% of students did not attempt to complete the bar chart. Students need to be aware that where a question number and allocation of marks is presented ie **01.6** and **[2 marks]**, an answer is required, even though no answer lines are given.

Almost half of students plotted the two bars in the correct positions, with the correct label. The most common mistake was to forget to label the bars. Other errors involved mis-plotting the bars and attempting to plot the data for fuel oil.

Question 2 (low & standard demand)

02.1 Around two thirds of students correctly identified the Group 1 elements as alkali metals. Other responses were fairly evenly spread between the other options.

02.2 By far the most common response was 'gloves', followed by 'apron/lab coat'. Credit was not given for these precautions relating to general good laboratory practice, although it was pleasing to see that most students were aware of them. The answers required related to this particular experiment. The highest scoring correct response was 'safety screen' - described in an assortment of ways, some of which (e.g. barriers) were not accepted.

02.3 Around 10% of students did not attempt this question. Many interpreted 'describe the trend' as 'describe the similarities', tending to state 'they all…' rather than comparing the reactions of the elements. Thus, more than half of students scored no marks. A few attempted to explain the trend in terms of the size of the atom; however, the command words here were 'describe' and 'give', not 'explain'.

02.4 Around 10% of students did not attempt this question. To be awarded the mark, students needed to communicate that the reaction was less controllable in some way, so statements such as 'very reactive' were insufficient, as potassium is also very reactive. Many students recognized the higher reactivity of rubidium, but the most common correct response referred to the reaction being dangerous.

02.5 Approximately one quarter of students did not attempt this question. Of those who made an attempt, a significant number did not realise that to balance an equation involved putting numbers in front of the substances shown. Some students wrote the name of the substance, others put symbols for various elements or compounds. Even though this should have been a familiar equation, many students tried to add additional reactants or products. Some students who realised that they had to balance the numbers of atoms of the different elements involved struggled to do this correctly. However, around one quarter of students gained the mark for this question.

02.6 About three quarters of students correctly identified NaOH as being sodium hydroxide. 'Sodium dioxide' was the least popular option.

02.7 Any value lying between the diameters of the sodium atom and the rubidium atom was credited as being acceptable, therefore allowing around 80% of students to gain the mark. It appeared that some students had realised what the value was, but did not put the decimal point in front, so answers of 444 and similar were seen. Some students chose a number which was nowhere near any of the values in the table.

02.8 More than half opted for the incorrect answer of 3.04×10^{-9} m. There was a fairly even spread between the correct answer of 3.04×10^{-10} m and the incorrect answer of 3.04×10^{-8} m, with very few choosing the fourth option.

02.9 Around 10% of students scored all three marks, with a further 10% scoring two marks.

The question asked students to include data from figure 4 in their answer. When students did not achieve all the marks, the main reason was that data was not included, was read incorrectly off the graph or did not include interpretation of the data, such as 'increased' or 'decreased'. Some gave correct data for one use but then generalized for the other two.

Some students were able to gain one mark for the general statement that the amount of lithium used in batteries and in the production of ceramics and glass had increased, whereas the use in lubricants had decreased.

A significant number interpreted the command word 'describe' as 'explain' and attempted to give reasons for why lithium was used more in batteries, etc. Some students mis-interpreted the question as being about the use of batteries, for example, and again attempted explanations as to why more batteries were being produced.

Question 3 (low & standard demand)

03.1 Most students were able to plot the points correctly, gaining two marks. Although a few drew a dot-to-dot line, the majority attempted a line of best fit. Unfortunately, not all were in the correct place – the most common error was to draw a straight line through the first, third and fifth points, leaving the second and fourth points below the line. Around 86% of students gained two or three marks. A small minority drew a bar chart rather than a line graph, which scored no marks.

03.2 Approximately 8% of students did not attempt this question. Two thirds of students were able to state a correct relationship. Students who did not gain the mark tended to use imprecise phrases such as 'the higher the electromagnet' or 'the bigger the size of the paper clips'.

03.3 Approximately 10% of students did not attempt this question. Many students realised that with five turns of wire, no paper clips would be picked up, but fewer were able to give a reason. The most common reason given was along the lines of 'it took 10 turns to pick up one', rather than a reference to the strength of the electromagnet.

03.4 Around 85% of students attempted this question. In general, students found suggesting improvements challenging, with fewer than 4% gaining both marks.

Those who described a correct improvement were able to gain one mark but were frequently unable to give a valid reason for the improvement – 'make it more accurate' or 'make it a fair test' were common reasons which were not credited. The most popular correct responses were to repeat the experiment and to go up in increments of 5 turns of wire.

A common error was to think that increasing the number of turns in regular increments such as ten turns at a time would be an improvement as it would make it a fair test.

Some students described how they could extend the investigation, rather than improve it, for example trying different metals instead of the iron nail or repeating with the nail at different distances from the paper clips.

03.5 More than half of students gained at least one mark, with around one quarter scoring both marks. All the options were chosen, with a fair number of students thinking that the colour of the insulation around the wire would affect the strength of the magnetic field around the electromagnet. Despite the instruction being to tick two boxes, around 10% of students ticked only one box.

Question 4 (low & standard demand)

04.1 Almost all students gained at least one mark, with around 60% gaining two. All of the options were selected. Despite the instruction being to tick two boxes, a substantial number of students ticked only one box.

04.2 Many students realised which feature of the graph showed the time when the heating was switched on. Around two thirds were correctly able to read the value from the graph as 110 minutes. A few misread the value as either 102 minutes or 120 minutes.

An answer of 150 minutes, the total time shown on the graph, was seen several times. Another answer seen several times was 40 minutes, this being the time from when the heater was switched off; this perhaps indicates that students had mis-read the question.

04.3 Responses were fairly evenly spread between ‘the time taken decreases’ and ‘the time taken increases’, with slightly more choosing the incorrect one (decreases). A very small minority chose the third option of the time staying the same.

04.4 This question was not very well answered, with only around 2% of students gaining all four marks.

The most common correct answer for the advantages was 'cheaper to run as you don't pay for electricity'. Some students correctly identified sunlight as renewable but could not clearly explain what renewable means. Students also accessed 'not using fossil fuels’ and ‘not releasing carbon dioxide’.

The main reason for students not gaining marks was due to vague answers such as ‘it is eco-friendly’ and ‘it is better for the environment’ without specifying in what way. Also answers tended to lack explanation, for instance ‘cheap’ as an advantage rather than it being cheap to run because the sun’s energy is free, or ‘expensive’ as a disadvantage, rather than it being expensive to purchase and install.

Many students used expressions such as ‘the sun is not always present’ or ‘the solar panels absorb the sun’ instead of referring to sunlight. Such statements did not gain credit.

Some students referred to the solar panels producing electricity, which was not the case here, as the question stated that they were used to heat water. Other students answered in terms of giving one advantage and one disadvantage of using an immersion heater, rather than the solar panels.

Question 5 (low & standard demand)

05.1 More than three quarters of students identified the given circuit symbol as a switch. Of the remaining responses, more chose the fuse than the other two options.

05.2 More than three quarters of students chose the correct response of 'electrolysis', with 'distillation' being the next most popular choice.

05.3 Around 17% of students gained both marks for this question. Students who scored one mark usually did so for correctly identifying the independent variable of 'concentration of copper sulfate solution'.

Although both 'concentration of copper sulfate solution' and 'mass of copper deposited' were chosen by a good number of students, these were often paired to the incorrect variable.

Other incorrect answers included various combinations of the type of variable and the description. Despite the instruction to draw one line from each type of variable, several students showed two lines from each.

05.4 Slightly more than one third of students chose the correct response that some copper fell off the electrode. The other two options were as popular as each other.

05.5 Around half of students were able to identify the pattern in the results and state the correct value of 0.16 g.

A common incorrect answer was 16 g, indicating that students had recognised the pattern, but had forgotten to include the decimal point.

Another common incorrect response was 0.07 g, which was the result given in the table; perhaps students had not taken on board the previous question which referred to this result as being anomalous.

05.6 Around 70% of students correctly identified that copper ions have a positive charge. Of the incorrect responses, 'a negative charge' was more popular.

05.7 Just over half of students realised that solid copper sulfate does not conduct electricity because the ions cannot move. The other three choices had a similar number of responses, with 'the ions are too big' being the least popular choice.

05.8 Around 8% of students did not attempt this question. Most of those who attempted it were able to substitute the given values into the equation and work out the correct answer, thus scoring two marks.

Some students substituted other values for current, such as 0.06 A or 6 A, rather than the given 0.6 A. It was not clear whether they had deliberately converted the value, or just made an error in writing it down. A few students divided the two values rather than multiplying them. It should be noted that in a low demand question where the equation is provided, it is always in the form needed, so no re-arrangement is necessary.

Question 6 (low demand)

06.1 Around two thirds of students were able to measure the angle (20°) correctly.

A large proportion of the incorrect answers were either 70° (90 – 20) or 160° (180 – 20), indicating that students were measuring the correct angle but were not too familiar with reading a protractor. Around 3% of students did not attempt this question.

06.2 Less than one third of students achieved both marks for this question. A fair number realised that vector and scalar went together but got the words in the wrong order.

All of the given words were used in a variety of combinations.

06.3 Around 12% of students did not attempt this question. Of those who did, the most popular correct answers given were gravity and weight.

Incorrect answers included quantities which were not forces but were linked to the investigation in some way, such as kinetic energy, movement and mass. Also seen were words which appeared to be totally unrelated to the situation, such as electricity, light and fractional distillation.

06.4 Twice as many students selected the incorrect response of ‘force is directly proportional to velocity’ than chose the correct response of ‘the resultant force on the block is zero’. The other two incorrect options had about the same number of responses as the correct one.

06.5 Students who understood the term ‘control variable’ were usually able to give at least one correct answer. Around 9% of students gained both marks, with a further 40% scoring one mark.

A large number of students thought that the nature of the surface and the force would be control variables, showing some confusion with independent and dependent variables. A small number of students gave random answers such as ‘oxygen’ and ‘valid’.

06.6 Around 70% of students gained the mark for the correct calculation of the mean. The most frequent incorrect response was 16.2 N, the sum of the three numbers,

06.7 Around 85% of students were able to identify glass as the surface with the lowest frictional force. The most common incorrect answer was 'cardboard'. Nearly 10% did not answer this question.

Question 7 (low & standard demand)

07.1 Around three quarters of students gained the two marks for this calculation.

10% did not attempt it, and a small number of students divided the two given numbers. Some students worked out the correct answer, then divided by 1000, possibly because the answer of 31 320 000 J looked very large.

07.2 Around one quarter of students did not attempt this question. Few realised that this was a question about useful and wasted energy and only 6% gained both marks. Those who scored one mark tended to get it for the mention of thermal / heat energy.

A common incorrect response was to refer to the energy being 'lost' rather than 'wasted'. Many seemed to think that the Moon's gravity affected how the energy from the batteries was transferred to kinetic energy.

07.3 Around 6% of students did not attempt this question. Around one third gave the correct value of 27%.

A fairly common incorrect answer was 73%, where the given values had been added, but not subtracted from 100.

There were a large number of answers in the region of 27, indicating that students knew what to do but either added the values together incorrectly or subtracted from 100 incorrectly. In some cases, working was shown which confirmed this.

07.4 12% of students did not attempt this question. Around one third of students were able to correctly identify both a similarity and a difference from the table, the majority choosing the aluminium and iron percentages respectively.

Despite the instruction to use the table of data, many students stated similarities and differences in texture, hardness, gravity, colour, density, etc. Such answers gained no marks.

Some students, although using the table, did not score marks because they did not 'add value' to the data. This was relevant for the 'difference' mark, where a qualitative description of the difference was required. For instance, an answer or 'iron' or 'iron is different' did not gain a mark, whereas 'Moon rock contains a higher percentage of iron' did.

07.5 Around 85% of student responses were correct. Responses for the incorrect options were fairly evenly spread, with 'scientists change their theories to make the theories more popular' being chosen more than the other two.

07.6 This was the first occasion in this paper where an equation had to be recalled. Nearly one third of students left this blank.

Of those who wrote something, some wrote an equation which was totally unconnected to the quantities listed. Some wrote expressions which were not equations, ie did not have an equals sign. Some wrote equations in the form of chemical equations, eg gravitational potential energy + mass → gravitational field strength + height.

Of those who wrote a mathematical equation connecting the given quantities, less than 20% gave a correct form of the equation to gain the mark.

07.7 More than one quarter of students left this blank, which tied in with the fact that many had left the previous question blank because they did not know the gravitational potential energy equation.

Of the students who attempted this calculation, many had difficulty manipulating an equation linking four quantities. Many combinations of the given values were seen, the most popular being to multiply the energy value by one of the other two quantities and then divide by the third. Some students took all three numbers, or just two of them and multiplied them together.

Question 8 (standard demand)

08.1 Around one third of students left this blank. Of those who attempted an answer, many did not draw anything resembling any recognised circuit symbol.

Some students realised that a resistor symbol would be part of the diagram, and some remembered that the symbol included arrows. Less than 2% gave a completely correct symbol.

08.2 Just over two thirds of students knew that one component would be in series and the other in parallel. The choices were fairly evenly matched, with the correct answer of ammeter in series and voltmeter in parallel gaining slightly more responses. Of the other two options, the two components in parallel was a more popular choice than them being in series.

08.3 More than one third of students did not attempt this question.

Many students realised that the given graph showed a directly proportional relationship; this gave them one mark. However, not many were able to correctly identify the features of the graph which showed this, or which would show an inverse proportional relationship.

Some students attempted to explain an experimental error which led to incorrect results.

08.4 More students left this question blank than attempted it. The vast majority of those who attempted the question drew a straight line through the origin with a negative gradient.

Fewer than 3% of students drew a correct line.

08.5 More than 20% of students left this blank. Of those who wrote something, some wrote an equation which was totally unconnected to the quantities listed. Some wrote expressions which were not equations, ie did not have an equals sign. Quite a number looked on to the following question and performed a calculation using the values given.

Of those who wrote a mathematical equation connecting the given quantities, just over 20% gave a correct form of the equation to gain the mark.

08.6 Linking to the previous question, as many students did not give the correct equation, they were unable to perform the calculation correctly, the most common error being to multiply the two given numbers.

Of those who divided the potential difference by the current, the majority did not attempt to convert the current value from mA to A; nevertheless, they were able to gain some credit. Of the few students who tried to do this conversion, most multiplied by a power of ten rather than dividing by 1000. Very few students scored all four marks.

Question 9 (standard demand)

09.1 Around one quarter of students did not attempt this question.

Of those who did, very few, around 1%, were able to draw the correct diagram. Some scored 1 mark, usually for the five single bonds within the bracket.

The most common incorrect diagram was just a repeat of the structure of ethene which had been given in the question. The significance of the 'n' was not understood by some students – some answers showed a pattern of 'n's around the outside of the bracket.

09.2 Around 8% of students gained both marks. Many students, around 50%, gained one mark, usually for pointing out that the LD poly(ethene) has side chains, whereas HD does not.
Despite the fact that both the polymer chains and the side chains were labelled, many students chose to ignore these terms to talk about 'wiggly lines' and 'a cracked appearance'.

09.3 More than 40% of students did not attempt this question.

Of those who did attempt it, some did not describe a method, merely stating that poly(ethene) extends when a force is applied.

Of those who attempted to describe a method, many failed to score more than two of the four marks available because their account lacked detail and would not lead to a valid outcome. In many cases, this was because 'see how much it stretches' was stated with no detail as to how this would be done. In other cases, there was no indication that more than one force would be applied to the poly(ethene).

There were quite a few references to pulling the polythene and examining it under a microscope.

A small number of students described the extension of a spring experiment, with no mention of poly(ethene) at all.

09.4 Around 10% of students gained one mark for this question, with a very small number gaining both marks. The answers tended to be very imprecise, such as 'HD needs a greater force than LD' and 'LD has a greater extension than HD'.

Many students stated that one extended faster than the other; as no time values were given, this is incorrect.

09.5 Around 18% of students scored two marks for this question, with a further 20% gaining one mark. Some worked out 85% of 8 billion, and quoted this as their answer, failing to subtract this from the original 8 billion.

A commonly seen error was dividing by 0.85 instead of multiplying.

Another common error was to put an incorrect number of zeros for billion (instead of just leaving it as 'billion'). Another common error was an inability to perform the percentage calculation correctly. To work out 85% of 8 billion, many students worked out 10% of 8 billion, and then 1%, then added 8 lots of 10% to five lots of 1%. Coupled with a large number of zeros, this method had the potential for errors to arise.

09.6 More than 20% of students did not answer this, the last question on the paper. Most students who wrote something made a good attempt at this 'evaluation' question based on LCAs. Many students were able to point out that bags for life were better from the point of view of 'waste'. A simple comparison for CO_2 emissions on a 'per bag' basis was also given by many. Few students processed the data for CO_2 emissions to show that on a 'per use' basis, bags for life were more environmentally desirable. Some students misinterpreted the word 'emitted' and referred to the use of CO_2 during the production and transport of the bags. Few students did calculations when comparing the data.

A Level 2 answer (three or four marks) involved comparing the two types of carrier bag qualitatively, eg 'more waste is generated from the production of one disposable bag compared with a bag for life' and addressing both waste and carbon dioxide. Around 40 % of students fell into this category.

A few students (around 4%) achieved Level 3 (five or six marks) for going a step further and involving calculations such as 'around two and a half times as much waste is generated from the production of one disposable bag compared with a bag for life'. In addition, both waste and carbon dioxide had to be addressed quantitatively. Also, a judgement needed to be made, either saying which type of bag was better, with reasons why, or giving the pros and cons of both types of bag.

Students whose answers were Level 1 standard (one or two marks) tended to discuss only one aspect of the information given, or to ignore the information altogether and write something from their own knowledge. Answers which merely stated the given information without any comparisons did not gain credit.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.