GCSE
COMBINED SCIENCE: SYNERGY

8465/3H: Physical sciences (Higher)
Report on the Examination

8465
June 2019

Version: 1.0

General

There were 9 questions with questions 1–3 being common with the Foundation tier.

The demand levels of the questions are designed to increase from standard demand to high demand through the paper, and as expected, students had more difficulty gaining credit in the high demand questions towards the end of the paper. This paper contained a number of demands on the students' mathematical abilities.

Students should be advised to always show clearly the method of their working when completing calculations. Questions 08.3 and 09.3 were, respectively, high demand chemistry and physics calculations. In both questions students often failed to score marks because of the layout of their work. If a student makes a mistake early in the calculation, but then goes on to use that incorrect result in the correct way for the rest of the calculation, it is sometimes possible to award marks for the subsequent steps. However, it becomes very difficult for examiners to do this if they cannot clearly follow the method the student has used. Other weaknesses in mathematical skills involved difficulty in converting units, eg megajoules to joules, and difficulty in transposing equations.

Many students seemed unfamiliar with laboratory techniques and equipment used in the Required Practical Activities (RPAs) from the specification. This was particularly evident in questions 05.1 and 08.

Levels of demand

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

- **standard demand** questions are designed to broadly target grades 4–5
- **standard/high demand** questions are designed to broadly target grades 6–7
- **high demand** questions are designed to broadly target grades 8–9.

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 (standard demand)

01.1 Around 16% of students knew that an enzyme is a protein molecule. The most common response was to say that it was a catalyst.

01.2 About 27% of students could describe the process of relighting a glowing splint as a test for oxygen. However, many students appeared not to be using the equation they were given, which told them oxygen was the gas and a significant number described the 'squeaky pop' test for hydrogen or used limewater as a test for carbon dioxide.

01.3 Many students could not name which indicator should be used. Those who did specify universal indicator often failed to say how they would determine the pH value from the colour indicated. Many referred to acids and alkali changing colour and the colour ranges, rather than being specific to a numerical pH value and a comparison with a scale or chart.

Approximately 12% of students were able to gain both marks on this question.

01.4 Around 86% of students could specify 7 as being the optimum pH. However, the most common incorrect answer tended to be ‘44’, the enzyme activity value for pH7.

01.5 Around 71% of students correctly identified the use of smaller pH intervals to find a more accurate value for the optimum pH.

01.6 Most students realised that the pH was too low for enzyme activity and also knew that this would lead to the enzyme being denatured. However, there were few references to the subsequent effect on the active site, with about 5% of students gaining all three marks.

Question 2 (standard demand)

02.1 Around 17% of students gave the resolution of the metre rule correctly. Common mistakes were to write down ‘1’ without any units or to write ‘millimetres’ without specifying a number.

02.2 Over a third of the students scored one mark here, as they realised that the paper clip must be made from a magnetic material such as iron or steel. About 2% of the students referred to the fact that the paper clips become an induced magnet when placed in the magnetic field of the magnet. A common misunderstanding was that all metals are attracted by a magnet.

02.3 More than half of the students realised that it was important that all the magnets used should have the same strength. A common answer that was not creditworthy was simply to say that this would make it a fair test, without any further explanation such as keeping the experiment to a single independent variable.

02.4 Less than half of the students correctly predicted either 6.9 or 7.0 as an appropriate value. 6.8 was the most common error. A few students wrote 6.85 as the average of 6.6 and 7.1, and some wrote 7 instead of 7.0.

02.5 About 65% of students gave a correct form of the equation linking resultant force, mass and acceleration. Those who chose to make resultant force the subject of the equation were generally more successful than those who chose to make mass or acceleration the subject.

02.6 Around 35% of students calculated the acceleration and half of these students went on to give the correct unit and achieve full marks. Common incorrect units were m/s or N/kg.

02.7 Less than half 48% of students knew that the core of the Earth was where most movements take place. Specifically it is the outer core which is liquid, although simply the word ‘core’ was allowed. Some students specified the inner core which was not given a mark as the inner core is solid. Crust, mantle and tectonic plates were common errors.

02.8 Around 12% of students gained the mark. Many students suggested that climate change was responsible. Other common incorrect suggestions were:

- the Moon
- the Earth's tilt
- tectonic plates
- migration patterns of birds.

Question 3 (standard demand)

03.1 About 63% of students correctly chose the correct answer for converting metres into nanometres.

03.2 Approximately 60% of students thought that graphene could be used to produce polymers. 25% answered correctly by identifying graphene can be used in composites.

03.3 A third **o**f students gained the mark on this question. A common mistake was to not refer to the comparative properties of the materials, eg saying that graphene is a good electrical conductor rather than being a better electrical conductor.

Some students talked about graphene being smaller, or referred to graphene being a single layer of graphite, which was given in the stem of the question.

03.4 Around 5% of students were awarded the maximum six marks on this question, with approximately 84% able to gain one mark or more in this question that differentiated well between students.

Responses often lacked detail about the structure and bonding of graphite apart from the delocalised electrons and layers. How graphite was a good conductor was not well explained. Very few students wrote about charge being carried or the electrons moving through the structure. The use of the word 'electricity' was often misused with students sometimes writing about electrons 'carrying electricity'.

Question 4 (standard, standard/high & high demand)

04.1 About 68% of students were able to give C_3H_6 to complete the equation, although a few had put a + sign between the C_3 and the H_6.

A common mistake was to add the two formulae that were given in the question to arrive at $C_{17}H_{38}$.

04.2 Students found this question very difficult, with very few scoring both marks on this question and around 81% scoring zero.

The most common answer to be worth one mark was to say that there were fewer intermolecular forces. The most common response which did not earn a mark was to say that there were fewer bonds to be broken.

Other misconceptions that appeared were:

- because there are fewer atoms in C_7H_{16}
- that boiling requires the breaking of bonds within the molecule.

04.3 Slightly less than two fifths of students obtained one mark by stating that as the pressure increased the yield would increase. Very few students obtained any more marks. Most tried to explain what was happening in terms of collision theory, but this was insufficient as it doesn't affect the yield.

Several students wrote about changing the pressure, but then did not specify whether this was to be an increase or a decrease so it was not possible to link their explanation to this. Some students gained credit for saying that the equilibrium moves to the side with the least molecules, but then did not link that to products. There were many incorrect answers included linking yield with temperature.

Many students misunderstood the unit 'atmospheres' and took it to mean 'the atmosphere'.

04.4 Around 18% of students were able to show how the data provided evidence for an exothermic reaction. Incorrect responses tended to be defining the term exothermic, or referring to pressure.

04.5 Few students could show a reaction profile and of those who did, many showed the profile for an endothermic reaction. Some students did try labelling the activation energy but their arrows were often sloppily drawn so that they did not show the true value. Many just drew straight line graphs or curves demonstrating a poor understanding of reaction profiles.

Around 4% of students were able to gain all four marks with about 61% of students scoring zero.

04.6 Less than 2% of students were able to score a mark on this challenging question. Most students referred to the fact that a catalyst only speeds up a reaction and does not itself get used up, rather than relating it to an equilibrium reaction.

Question 5 (standard/high & high demand)

05.1 Many students drew the correct symbols for the ammeter, voltmeter and thermistor. The most common mistake was to draw a variable resistor's symbol for instead of the thermistor.

Most students knew that the voltmeter should go in parallel with something, but did not always choose the thermistor. A significant number of students did not use a ruler to draw their diagram.

Around 13% of students gained all three marks on this question. More than half scored zero.

05.2 More than half of the students gained all four marks for a determination of the temperature of the thermistor. Some students correctly calculated the resistance of the thermistor but then wrote that value down as the temperature, instead of reading the value off the graph. These

students often wrote that: $\frac{V}{I}$ = temperature

Some students both multiplied and divided the values, giving two answers. Some students misread the graph.

05.3 Around 37% of the students recognised that the gradient of the graph was the steepest at this range of temperatures. Few students could then explain that in this region there would be a bigger change of resistance for the same change in temperature. Some recognised there was a larger change in resistance but didn't relate it to the same change in temperature, often referring to time or speed.

Question 6 (standard, standard/high & high demand)

06.1 Almost a third of students correctly suggested using a gas syringe to measure the volume of gas produced. Of those who suggested collecting the gas over water, very few mentioned that the gas should be collected in a vessel with a scale on it so that the volume could be determined.

06.2 Less than half of the students scored full marks on this question.

Common errors included:

- not including the values 0,0 in the table
- using '20 second intervals' as a heading instead of time
- writing units in the columns rather than the table heading.

A few students drew a graph instead of a table.

06.3 Few students drew a tangent on the curve line in the graph. Of those who did, most managed to score all four marks. Approximately 11% of students were able to gain all four marks on this question and around 64% scored zero.

Those students who did not draw a tangent often divided 60 by 30. However, many of these then failed to note that the answer was required to be given to two significant figures, and wrote 2 instead of 2.0.

06.4 Around 53% of students could gain one mark for saying that the energy of the particles increases at higher temperatures. Many of these could then go on to say that this would lead to more frequent collisions.

Very few students referred to the activation energy. Several students were relating it to a change of state, or particles vibrating. Simply saying ‘more collisions’ without relating to frequency or probability was insufficient.

Question 7 (standard, standard/high & high demand)

07.1 Many students tried to relate the strength of alloys to the bonding between the different atoms. Another common mistake was simply to state the definition of an alloy.

A good number of students realised that the strength of an alloy was something to do with the fact that it contained different sized atoms, but then often found it difficult to explain why this would make the alloy strong.

Common misunderstandings were:

- using the term ‘particle’ or ‘molecule instead of ‘atom’
- references to the bonds being stronger making the alloy harder
- references to density.

Around 15% of students were able to score one or more marks for this question.

07.2 Approximately 12% of students gained the mark on this challenging calculation question to obtain a ratio of moles.

07.3 Around 62% of students knew the correct value of the Avogadro constant.

07.4 About 31% of students scored both marks on this question. Many students however were unable to convert nanograms to grams correctly.

07.5 Approximately 12% of students could work out the empirical formula of silicon oxide correctly. The most common incorrect response was Si_8O_{16}.

Many took the limitations of the diagram literally, not realising that the structure continued, and so got the bonding numbers rather confused. This led to several students giving the answer ‘24’, which was the number of atoms shown.

07.6 Around 7% of students obtained three marks, and approximately 56% of students gained at least one mark. Some students incorrectly wrote about ionic or intermolecular bonds, and referred to strong structure rather than strong bonds. The numbers of each Si and O atom bonded to each other was often inaccurate.

Question 8 (standard, standard/high & high demand)

08.1 About 15% of students knew that it was necessary to add excess copper oxide in order to ensure that all the acid had reacted. A few thought it was linked to crystal size.

08.2 Almost a quarter of students gained one mark or more on this question based on an RPA. Some students could state that the liquid should be filtered in order to remove the excess copper oxide, but few were able to describe and explain the correct process for evaporating the water.

Others mentioned larger crystals but none compared it with the powder that would be produced from step 5. Many simply wanted to repeat the experiment.

08.3 A fifth of students gained one mark or more on this question. About 2% of students scored all five marks on this question. These were generally students who laid out their work clearly and wrote down what each number represented, thus reducing the chances of making a mistake.

The calculations shown by most students were not well laid out and unstructured. It was often difficult to see where numbers had come from, and whether they were trying to do a calculation for copper oxide or for sulfuric acid.

Many students could make a start by calculating the relative molecular mass of copper oxide to be 79.5 but then couldn't calculate the correct number of moles. This was because they used the relationship that the number of moles = $\frac{M_r}{\text{mass}}$, rather than $\frac{\text{mass}}{M_r}$

Finding the number of moles of sulfuric acid proved even more difficult for most students. In particular, students had great difficulty in converting dm^3 into cm^3.

Question 9 (standard, standard/high & high demand)

09.1 Most students were able to score the first two marks on the mark scheme for saying that closing the switch completed the circuit so there was a current in the wire. Few went on to state that this caused the wire to have a magnetic field around it which interacted with the field from the magnets.

A significant number of students answered in terms of closing the switch meant that the circuit was turned off. Other common mistakes and misunderstandings were:

- references to electricity rather than current
- thinking that a surge of electricity/current caused the movement in the wire
- forces were rarely mentioned
- believing that the wire would be attracted to the magnets.

About 59% of students gained at least one mark in this question that differentiated between high-attaining students well.

09.2 Approximately 13% of students scored both marks. Many students found it difficult to express themselves clearly. Expressions such as 'flip the battery' or 'turn the battery round' were too vague to gain credit.

09.3 Almost a third of the students gained one mark or more on this question for calculating the time to charge the battery. Many students calculated the power to be 45 watts, but often could go no further.

Some students did not lay out their working clearly, making it difficult to see what they were trying to calculate. The most common mistake converting megajoules to joules incorrectly, Many students multiplied by one thousand instead of one million.

09.4 About 8% of the students scored both marks for giving the properties of the mains supply. Most students referred to the use of transformers rather than to the potential difference or frequency of the supply.

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.