GCSE

COMBINED SCIENCE: TRILOGY

8464/C/2H: Paper 2 Chemistry Higher
Report on the Examination

8464
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General

This was the second session for this reformed specification, which is assessed by two terminal examinations in each science. This paper was out of seventy marks and the students had 75 minutes in which to complete it. There were seven questions on this paper. Questions one and two were common to the Foundation and Higher Tiers and were targeted at grade 4/5.

The level of demand of the questions is 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, particularly Q05.4, Q06.2 and Q07.4, towards the end of the paper.

There are three assessment objectives. Approximately 40% of the marks on the paper are for demonstrating knowledge and understanding of: scientific ideas, scientific techniques and procedures (AO1), approximately 40% on application of knowledge and understanding of: scientific ideas; scientific enquiry, techniques and procedures (AO2) and approximately 20% for analysing information and ideas to: interpret and evaluate; make judgements and draw conclusions; develop and improve experimental procedures (AO3).

Students should be prepared to expect that they will be given unfamiliar contexts and information that assess these objectives. Familiar contexts are those mentioned in the specification and assess recall, selection and communication of students' knowledge and understanding.

Given the requirement for 20% of marks on the paper to have a mathematical base, many students made good attempts at the mathematical questions.

A few students struggled with the extended response question Q02.2. Students should be advised to always take note of the command word in these questions. In this paper question Q02.2 asked students to 'Evaluate'. In many cases students gave a comparison using the figures in the table but did not go on to offer a judgement.

It appeared that most students had sufficient time to complete all the questions. As always, students are reminded to write in black ink. Where handwriting or number formation is poor, examiners make every effort to read what is written, but some answers can be very difficult to read.

This report should be read in conjunction with the published mark scheme.

Levels of demand

Questions are set at 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 About 91% of students gained this mark. 'Filtered' water was the most common incorrect response.

01.2 Just under a third of students gained some credit for being able to describe the test and result for pure water. ‘Boil’ was often given as the test but ‘100 °C’ was often omitted from their response for the result. Many students answered in terms of evaporation or distillation of the water, stating that no solid would remain, which was credited with one mark. The use of pH indicator, litmus paper and anhydrous copper sulfate were common incorrect responses.

01.3 Students were asked to describe a method to determine the mass of dissolved solids in a $100cm^3$ sample of river water.

About 17% of students gained full marks on this question and a further 13% of students achieved marks in level 2. To access level 2, students were expected to give a logical plan that would lead to the production of valid results, as stated in the generic level descriptor in the mark scheme.

Just under half of the students gained marks in level 1 by providing a plan that would not necessarily lead to valid results.

Students who gained level 2 marks based their responses around the work undertaken in Required Practical Activities; either heating the water in a suitable container to dryness with a Bunsen burner or water bath or alternatively distilling the river water and subsequently weighing the mass of solid that remained in the flask.

Students who gained marks in level 1 often omitted to state in their method:

- the volume of water that they would use
- evaporating the river water until dryness
- the recording of weighings at appropriate times.

Many student responses give simple filtration as the method used to collect the dissolved solids and weighed what was on the filter paper. Some students were experimenting to see how much solid would dissolve in the river water and a few students gave detailed descriptions of water treatment processes.

Some students were able to provide a logically sequenced method, clearly based on the practical work they had previously undertaken.

01.4 A minority of students gained full marks but many students gained some credit for their calculation. The two conversions (mg to g and cm^3 to dm^3) were a problem for many students, multiplying by 10 or 100 was regularly seen. Some students did not convert the figures at all whilst other students divided one number by the other. The common answers that gained 3 marks were 31, (only one conversion) or 0.03125, (not converting their calculation into 2 significant figures). The most common answers that gained 2 marks were 310 (mass × volume, with incorrect conversions but an answer given to 2 significant figures) or 31000 (mass × volume to 2 significant figures). Some students chose to divide the mass by the volume as a density calculation.

01.5 Almost three quarters of students gained full marks on this question. The most common mistake was subtracting 44mg from the maximum 500mg permitted, then converting into a percentage (91.2%) to calculate the mass of dissolved solids.

Question 2 (standard demand)

02.1 Just under a quarter of students gained some credit, mostly for stating that oxygen and nitrogen react together in the engine. Fewer students highlighted the need for high temperatures to be present for the reaction to occur. Many students stated that the nitrogen originated as part of the fuel rather than from the atmosphere.

02.2 This question proved very accessible to the students. More than half of the responses were judged at level 2, with approximately further 14% judged at level 3.

The command word for this question was ‘Evaluate’, which requires students to give a judgement strongly linked and logically supported by a sufficient range of correct reasons. In their responses many students simply gave a weak judgement, including a sentence at the end of the answer offering an opinion as to which car was ‘best’ or ‘efficient’ or ‘the most eco-friendly’. To be a valid level 3 judgement, students should directly link the judgement to several items of data drawn from Table 3.

Some students were able to use the data in Table 3, and project each car’s carbon footprint beyond 100 000km: ‘Although, car A has the lowest mass of CO_2 produced during manufacture, it has the highest value of CO_2 kg/km when driven and this will mean that eventually it will become the most polluting vehicle’, or writing the converse argument for car C.

A substantial number of students gave linked comparisons between the cars, or linked a judgement with a single reason, for example, ‘Car A produces the least carbon dioxide during manufacture, but the most per km when driving’. These students were awarded a mark in level 2.

A few students simply added the values from the four columns in Table 3, ‘Car C produces 75160.044kg carbon dioxide which is bigger than the others’.

Question 3 (standard/high demand)

03.1 A minority of students knew the definition of a formulation from the specification or were able to give an equivalent statement. Often students mentioned that it was ‘a mixture’ or ‘chemicals mixed together’ but omitted the idea of ‘to form a useful product’. Some students were able to give examples, but not a definition.

03.2 A large number of students did not explain how chromatography separates the dye. Instead they explained in detail how a chromatography experiment would be undertaken to separate the dyes.

Just over a third of students gained some credit, mostly for the idea that different dyes had different solubilities. A significant number of students incorrectly stated the reason was related to the densities of the dyes. The second marking point was for conveying the idea that the different dyes travel up the chromatography paper at different rates/speeds or distances. However, there were many vague responses referring to different points or places.

03.3 The majority of students gained at least one mark but only a small minority gained both marks. Responses referred to the food colouring separating into more than one colour/spot/dot on the chromatogram but rarely indicated that these colours/spots would appear vertically above the original dye. Some students described how it was possible to identify the colours separated by 'matching them against other colours', which was not asked for in the question.

03.4 Many students failed to gain the first marking point due to not elaborating on 'do the chromatography experiment' rather than explain (as requested by the command word) how to conduct the experiment.

Students gained credit for stating that the distances travelled needed to be measured or the R_f values calculated, but then omitted to state how these values could be used to either confirm the identity of the unknown dyes or identify which dyes remained unidentified.

Question 4 (standard/high demand)

04.1 The majority of students who obtained marks on this question did so from the first 2 marking points, although then many continued to describe the next process incorrectly as 'electrolysing the copper metal from the ash'. Converting the copper compounds found in the ash into a suitable copper solution or electrolyte, was rarely seen in the student responses. A significant minority of students who gained no marks on this question did not seem familiar with the process of phytomining, and gave answers based around normal mining, or heating the rock until the copper melted.

04.2 Around 73% of students gained some credit on this question, predominantly for correctly calculating the M_r of copper sulfate (159.5), although 111.5 (addition of all the A_r given in the question) was given regularly. The most common mistake was to multiply the figures (0.319 x 159.5) rather than divide ($\frac{0.319}{159.5}$). 15% of students scored all three marks, many giving their answers in standard form (2×10^{-3}), which, although not asked for, was accepted.

04.3 About 84% of students gained this mark with no pattern seen in the incorrect responses.

04.4 Only a few students achieved both marks by correctly linking the idea that the amount of CO_2 used to produce ethanol would be the same as would be released when the ethanol was burned. The vast majority of correct answers for both marks were based on the large amount of CO_2 in the air, and its regular replacement by burning fossil fuels. About 23% of students achieved 1 mark for highlighting that there was sufficient carbon dioxide in the atmosphere or that it is produced from the combustion of ethanol.

04.5 Around 17% of students gained credit on this question by recalling the definition of sustainability from the specification or were able to give an equivalent statement. Most students answered in terms of environmental issues or renewable routes, including 'long lasting' and 'won't run out'.

Question 5 (standard/high demand)

05.1 Around 6% of students gained this mark. The third option was the most popular incorrect response.

05.2 About 65% of students gained this mark. Most students gave the correct symbol equation rather than the ionic equation.

05.3 This question produced a good spread of marks, with only 2.5% of students failing to gain any credit for their answer. Around 27% of students gained all three marks. Most students gained 2 marks and just below a third gained one mark.

Common errors included:

- failing to plot the point at the origin
- incorrectly plotting the points (particularly 35, 36.0 and 95, 59.0), lines of best fit that were sketched
- drawing a straight line of best fit rather than a curved line of best fit
- lines of best fit that extended too far above the plateau
- 'double lines' drawn as part of the curve.

Points plotted as 'crosses' are easier to see and mark as opposed to those points plotted as 'dots', though large, heavy crosses make it difficult for examiners to determine whether the plotted points are within tolerance and risk losing credit.

05.4 Few students gained any credit on this question. Many responses incorrectly described the change in volume of gas evolved rather than the change in the rate of the reaction. Those students who gained one mark usually did so by identifying the point at which the rate of reaction became zero (read from their graph). However, some students used the figure from Table 2 (120 seconds) to identify when the reaction stopped, which did not reflect the time indicated by their graph, so consequently gained no credit.

05.5 In this question more than a third of students gained some credit for their response, however, only about 1% of students obtained all 3 marks. Very often students would answer in terms of the reaction getting faster (rather than slower), 'the particles gain more energy and move about faster causing more frequent collisions' or would give a detailed answer covering all aspects of the collision theory rather than explaining the rate changes for the reaction given in the question.

Some students did not gain the last marking point because they referred to both reactants being 'used up' at the end of the reaction rather than just one reactant or it being a limiting factor.

Question 6 (standard/high demand)

06.1 The correct test and result for oxygen gas was known by about 54% of students. Using a splint (not glowing) or a 'blown-out splint' to test for oxygen were the most frequently seen incorrect answers.

06.2 Less than a quarter of students achieved credit on this question, with around 4% of students achieving both marks. Students were able to suggest a shift in the equilibrium but often in the wrong direction. Few of the students who correctly answered the directional shift were able to explain why. Many students simply suggested 'to counteract the change'. The most common correct response was 'to re-establish equilibrium'.

06.3 Over a quarter of students gained full marks and around 80% of students gained some credit for their calculation. The most common answers that gained either 1 or 2 marks were for correctly calculating the M_r for calcium oxide (56) and/or calcium sulfite (120). The highest-attaining students were able, through a variety of approaches, to successfully calculate the mass of $CaSO_3$ produced (15.0g). Using a ratio approach was more popular than using moles as a method to arrive at the answer.

The most common mistake seen was to multiply the mass of CaO by the M_r of $CaSO_3$ ($7 \times 120 = 840$).

Question 7 (high demand)

07.1 This question produced a good spread of marks, with around 83% of students gaining some credit for their answer. A minority of students gained all four marks, whilst just over half of the students gained either 1 or 2 marks. Students most commonly did not include the idea that the fractionating column had a temperature gradient. Some students explained in detail what each of the fractions was used for and a few students incorrectly incorporated 'cracking' into their response.

07.2 Almost 60% students were able to correctly identify 'different amounts of oxygen' or state that 'the first reaction is complete combustion and the second is incomplete combustion'. Some students wrote 'carbon dioxide and water' which did not answer the question that was asked. Several students stated that 'in reaction one the hydrocarbon is an alkane and in the other reaction it is an alkene'.

07.3 Just over 43% of students successfully balanced the equation for the combustion of butane. Multiples were regularly seen, and full credit was available if these were correct.

07.4 Many students were unable to describe in detail the greenhouse effect in terms of long and short wavelength radiation. Responses were confused as to which type of wavelength would pass through the atmosphere; 'reflected' or 'bounced off' were not creditworthy alternatives to 'longer wavelengths being re-emitted'. About 32% of students gained one mark for identifying that the 'temperature increases'.

Approximately 10% of students made no attempt at this question.

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.