GCSE
CHEMISTRY

8462/2H: Paper 2 - Higher
Report on the Examination

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General

There were ten questions on this paper. Questions 1–3 were common to the Foundation Tier. Many students gave responses which showed an excellent understanding.

The mark scheme was designed to allow students to achieve marks for showing knowledge, understanding and application of chemistry. Knowledge and understanding of how science works in everyday situations, including in the laboratory, were tested throughout this paper. This means that it was essential that students read and analyse the information provided before writing their response. The standard demand extended response question caused few problems with many students achieving full marks.

Many students now answer questions on topics which have been part of preceding specifications for many years with confidence. Such topics include equilibrium and qualitative analysis. Topics which are new to this specification are more problematic. Formulations, composites and condensation polymers fall into this category. The new requirement for students to calculate instantaneous rates of reaction from graph tangents has led to confusion between this and the use of graphs to calculate mean rate of reaction over a specified time interval, as required here.

The majority of students appeared to have sufficient time to complete the paper. A few used up a lot of time and space in practical and extended writing contexts by providing detailed additional information that did not contribute to a fully answered question.

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 The most common correct answer was 450 °C. More than 80% of students gained this mark.

01.2 The most common incorrect responses were descriptions of chain lengths; however, these answers often went on to make a correct link with boiling points. Occasionally, the link with relative boiling point ranges was given the wrong way round. More than two-thirds of students gained both marks.

01.3 Chain lengths were again often referred to rather than properties. Students still have the misconception that fuels need energy to burn, particularly those which do not ignite easily. All three correct properties were identified with roughly equal frequency. Over a third of students gained both marks.

01.4 The vast majority of students were able to apply the C_nH_{2n+2} rule to identify hexane in the list of formulae.

01.5 The need for a high temperature was most frequently seen as a correct answer; however, students do need to take care when expressing themselves, frequently using hot or heat instead of high temperature. If a temperature was specified, it had to be above the boiling point range of the diesel oil fraction. The catalyst, often incorrectly named, was the more common of the two alternatives for the second marking point. Around two-fifths of students gained both marks.

01.6 Students found difficulty in expressing the idea of greater demand for smaller hydrocarbon molecules, and the uses were more commonly seen in responses. Approximately one-sixth of students gained both marks.

01.7 More than nine in every ten students gained this mark for completion of an equation.

Question 2 (standard demand)

02.1 Most students coped well with this question. More than two-fifths of students gained a Level 3 mark, and more than three quarters gained at least a Level 2 mark.. In the carbonate test, there were some that just added limewater straight to the carbonate and said that it would go cloudy. Others added the tablet to a mixture of limewater and hydrochloric acid. However, there were many good descriptions of the use of delivery tubes or pipettes to transfer carbon dioxide from the acidified tablet in one flask or tube to the limewater in another. The flame test was well described by the majority. Although ‘red’ was permitted as a correct flame colour for lithium ions, its use is discouraged because of the possible confusion with calcium. Some students thought that they needed to sterilise an inoculating loop before using it in a flame test – a possible confusion with agar plating procedures in biology. Less effective responses introduced whole tablets into the flame, or used the wire provided to cut it up.

02.2 The idea of a formulation is still not very well understood. The similar words ‘formula’ and ‘formulate’ are not synonyms and gained no credit. There were many references to compounds, medicines and drugs. Just over half of the students gained this mark.

02.3 The calculation of percentage by mass of lithium carbonate in the tablet was well done by many students, with more than four-fifths of students gaining all three marks. Common errors included failing to convert to common mass units, and then calculating the fraction the wrong way up to obtain a percentage less than 100%. A common error was to divide by 100 instead of 1000 when converting from mg to g.

Question 3 (standard demand)

03.1 The expression ‘aq’ was credited with or without brackets. Some students named the symbol ‘aqueous’ and gained credit that way. More than nine in every ten students gained this mark.

03.2 The majority of students gained one mark for naming a piece of apparatus capable of measuring volume or mass change. However, the question asked for equipment to measure the rate of production of gas and therefore apparatus that could be used to measure time was required for the other mark. This aspect was less well answered with a much smaller number of students achieving this mark. Around a quarter of the students gained both marks.

03.3 The question was generally well answered with many scoring full marks. The plotting of points was accurate in many cases and if an error occurred it was usually as a result of incorrect plotting of one of the first two points.

A greater number of students did not gain credit for the line of best fit, generally as a result of drawing a straight line. There were few instances of straight line linking between successive pairs of plotted points, but multiple, excessively thick or ‘feathered’ lines were not awarded the mark.

03.4 This proved to be a difficult question, with fewer than 10% of students gaining all three marks. A large number of responses correctly identified that the rate of reaction decreased as time increased. However, others asserted more vaguely and ambiguously that less gas was produced as time increased. A significant number of incorrect responses referred to the rate at ten seconds being the highest. The table of results gave no information about the rate before ten seconds so credit could not be given for this point. A slightly smaller number of answers correctly referred to the fact that the reaction had finished by 60 seconds. However, correct answers relating to the rate at which the rate changed during the experiment were rarely seen. Students should not assume that a graph with this general shape shows inverse proportionality.

03.5 Most students recognised that the higher temperature would increase the rate of reaction, and were able to identify the correct links to a faster reaction. Nearly three-quarters of the students gained both the marks.

Question 4 (standard and standard / high demand)

04.1 More than half of the students were able to score three marks, but fewer than 10% gained all five. Most students commented somewhere in the response that both air/oxygen and water are needed for the rusting of iron. The question was generally well answered for test tubes 1, 2 and 3. Some students failed to say whether rusting would be observed even though they had mentioned the conditions within the tube. Test tube 2 was often described as lacking both water and air (because there was a stopper in the tube). Test tube 4 caused some students to introduce the word ‘galvanised’, others described what would happen if the paint was scratched and some stated that the paint was a sacrificial coating. Few students gained the mark for test tube 5, most saying that the stainless steel nail will not rust because stainless steel does not rust.

04.2 Sacrificial protection was a common answer, however a considerable number of students failed to mention that magnesium is more reactive than iron. Many students appeared to think that the ship was coated in magnesium which behaved as a barrier to corrosive agents or was analogous to galvanising. Nearly 40% gained both marks.

04.3 Many students stated that the lack of corrosion was due to the window frames being painted or covered in plastic. Although the first mark for ‘aluminium oxide’ was often gained, the second mark, for explaining how this prevents corrosion, did not always follow. Fewer than 20% gained both marks.

Question 5 (standard / high and high demand)

05.1 The majority of students could identify wood as a renewable resource or methane as a finite resource, however few could state that the burning of wood is carbon neutral. Some students however were able to state that wood does not contribute to global warming. While the vast majority scored one mark, fewer than 20% scored both.

05.2 This question was answered well, with around half of the students gaining both marks. Marginally more students knew the term ‘incomplete combustion’ than could explain its cause. Some students stated that generally there was never enough oxygen in air to combust methane completely, or that there was no oxygen available at all.

05.3 Balancing equations is a skill that is examined regularly but is still not performed well by some students. However, nearly four-fifths did score this mark. Correct examples of multiple/fractional balancing were seen.

05.4 This appeared to be an unfamiliar concept for most students and they found this question difficult. Some students could identify the 5:3 ratio from the equation, whilst others were able to convert from dm^3 to cm^3 and hence gain some marks. Many students did not appear to be able to bring the fact that the volume of any gas is proportional to the number of moles present to this question, and therefore involved the 24 dm^3 molar gas volume in their calculation. Many others did no more than subtract 3.60 dm^3 from 7.25 dm^3 and convert the answer to cm^3. A common error was to divide by 100 instead of 1000 when converting from mg to g, or to multiply by 1000 instead. Fewer than 10% were able to score three or four marks, and more than half gained no mark at all.

Question 6 (standard / high demand)

06.1 This was generally well answered, with nearly three-quarters of students gaining both marks. Most responses included the double bond in the correct position. A fairly common error was to leave the trailing bonds, resulting in each carbon atom in the double bond having 5 bonds, rather than 4. The brackets and ‘n’ from the polymer structure were often retained, and although not penalised, this practice should be discouraged.

06.2 This was also generally well answered, with nearly two-thirds of students gaining this mark. Where students did not know the name of the carboxylic acid group their incorrect response was often ‘alcohol’.

06.3 Most responses correctly named the small molecule released in condensation polymerisation as water, although a significant minority opted for ester. Over two-thirds of students gained this mark.

06.4 About 50% of pupils either did not know, or could not recall the term ‘thermosoftening’. A significant minority referred to ‘thermoforming’. For the second mark, responses often talked about weak intermolecular forces but then went on to incorrectly state these were ‘between monomers’. Other responses vaguely talked about ‘weak forces’ without any further clarification. References to weak covalent bonds were also often seen. Nearly a quarter of students gained both marks.

06.5 A significant minority of students identified the two components of a composite material but confused them in this context. Such students were awarded one mark. Around a quarter of students gained both marks.

06.6 Describing the consequences of the properties of the surfboard, rather than focusing on the properties themselves were the most common responses which were not credited in this question. Only just over 10% were able to give two creditworthy properties.

Question 7 (standard and standard / high demand)

07.1 Sodium hydroxide was well known as the test reagent for identifying aluminium ions. Incorrect reagents, used by themselves or in conjunction with sodium hydroxide, included hydrochloric acid, sodium sulfate, sodium chloride, sodium carbonate, silver nitrate and barium chloride. Other students suggested electrolysis, the use of universal indicator or described boiling the water to leave a residue.

The drinking water / solution does not turn white when sodium hydroxide is added but forms a white precipitate.

Students needed to mention that sodium hydroxide was added in excess somewhere in their response and to be clear that it was the precipitate which dissolves. The precipitate does not go colourless or clear. Terms such as solid / suspension / residue were considered equivalent to precipitate but milkiness / cloudiness were not. Nearly a quarter of students gained all three marks.

07.2 The use of barium chloride in the presence of hydrochloric acid for identifying sulphate ions was well known. Incorrect reagents included using hydrochloric acid alone, barium, silver nitrate or sulfuric acid. $Ba^{2+}(aq)$ is not a reagent but allowed access to the second mark if stated.

The drinking water / solution does not turn white but forms a white precipitate when barium chloride is added. A white precipitate that redissolves is a contradiction and was not creditworthy. Around 30% of students gained both marks.

07.3 There are several ways to carry out this investigation and there were many creditworthy suggestions. Access to Level 2 was broadly dependent on weighing the empty container (usually a beaker or evaporating basin) and knowing how much water was used (usually "the sample" or a specified volume such as 100 cm^3). Heating to constant mass was often not stated as such but heating to remove all the water was well known.

Some students described distillation and focused on collecting the distillate. Other students described partial evaporation and crystallisation, leaving the dish on a window ledge to allow crystals to form before drying the crystals on a paper towel. About a third of students provided a Level 2 response.

Question 8 (standard / high and high demand)

08.1 This question required knowledge, understanding and application to explain why living organisms could not have evolved in the same way on Titan as on Earth. Of the three marks available most marks scored were for no (or little) oxygen and no (or little) carbon dioxide. The link between these gases and photosynthesis appeared to be less well understood.

Very few answers were in terms of the evolution of oxygen-using animals; answers tended to use the more general term organism or indeed just stated that no life would have evolved.

There were also attempts to answer this question by suggesting that life would have evolved to use either nitrogen or methane.

Even though there was no information in the question about water some answers were provided in terms of no water being available for life in oceans to have evolved.

Students also framed answers in terms of Titan being too cold for life to evolve or that methane enhanced the greenhouse effect making temperatures inhospitable for life.

Answers that scored no marks at all tended to be entirely about how the atmosphere on Earth is thought to have changed and consequently how life evolved on Earth with no link being made to Titan. Three-quarters of students gained at least one mark, but fewer than 15% scored all three.

08.2 In general the responses to this question showed that the mechanism by which greenhouse gases cause the greenhouse effect appears to be poorly understood.

Most answers which scored no marks described rays bouncing both off the planet and the atmosphere. The idea that methane forms a blanket that traps the Sun's rays or bounces back, traps or retains (often unspecified) radiation were common explanations.

Answers rarely correctly specified the incident and outgoing radiation from Titan's surface; confusing long wavelength and short wavelength radiation was common. Infra-red radiation was often described as heat rays or heat energy.

The second mark was infrequently scored. Many answers described rays of some kind being bounced back, reflected, re-reflected, or refracted from the surface. Only around one in twenty students gained all three marks, while two-thirds gained no marks.

08.3 About a third of students provided both a correct test for unsaturation and a valid result. If one mark was scored it was usually either due to using the term clear instead of colourless or forgetting to mention the original colour of bromine and just giving the final result.

Question 9 (standard / high demand)

09.1 This was mostly correctly answered, with about 70% of students knowing the test and the result. A few students stated that a splint that had gone completely out would relight.

09.2 Most students recognised that either the mass of manganese dioxide or the temperature needed to be control variables but were not given as such in the given method. Approaching half of the students identified both.

09.3 Many students did not know how to find a mean rate of reaction. Of those who did, many calculated the rate per minute rather than per second, as required. Some took gradients at 2 minutes and 4 minutes, found both instantaneous rates, and then averaged the two results. This gives an answer which is close to the correct value but still incorrect. Others found the mean rate over the first 2 minutes, another mean rate over the first 4 minutes, and averaged those values: an approach which was completely incorrect. It was sometimes not possible to follow a student's working, with figures appearing without clues on the graph as to where they had come from. Around one-fifth of students gained full marks.

09.4 Most students realized that the reaction would be slower, so the graph should be less steep. However, very few realized that there were now only two-thirds the original number of moles of hydrogen peroxide, so only two-thirds the volume of oxygen would be produced. Some students appeared to think that a limiting reactant was involved, even though only a single reactant and a catalyst were present. Thus, roughly four fifths of students drew a shallower curve, but only one in twenty levelled it off at 40 cm^3.

09.5 Many students realised that manganese oxide powder had a larger surface area than lumps, although a few had this the wrong way round. Fewer students confused increasing frequency of collisions with increasing energy than in the previous series. Around 40% gained both the available marks here.

Question 10 (standard / high and high demand)

10.1 Nearly half of the students scored both marks. Students who provided incorrect responses either ignored the stoichiometry of the equation or did not know the expression which represents atom economy.

10.2 The idea that lower pressure increases the yield was understood by many of the students but some had difficulty explaining why. Around a third of the students scored both marks.

10.3 Around a third of the students scored this mark. The fact that there was the same number of moles on each side of the equation was often ignored by students. Instead, these responses focused on an increase in pressure increasing the rate of reaction and therefore assumed that this would increase the yield.

10.4 This was well done by many of the students although reading the graph was problematic for some. Misinterpreting the *y*-axis scale and/or using a wrong curve were the most frequently seen sources of error. Around two-thirds of the students scored all three marks.

10.5 Most students recognised that 285 atmospheres is more expensive but many failed to explain why in terms of energy or cost of plant construction. There were also many vague references to danger or safety. Around a third of the students scored this mark.

10.6 Around half of the students scored this mark, having interpreted the graphs correctly and recognised that increasing / decreasing the temperature decreases / increases the yield of ammonia.

10.7 Many students recognised that the world population had increased since 1950 and that the demand for food had also increased. Students who did not gain the second mark did not relate the increase in demand for ammonia to an ammonia-based product. Around 40% of the students gained both marks.

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.