GCSE
CHEMISTRY

8462/2H Paper 2 Higher Tier
Report on the Examination

8462/2H
June 2023

Version: 1.1

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General Comments

Well over 100,000 students sat this component, so a very wide and varied range of responses was seen.

Many students gave responses which showed excellent and comprehensive understanding of Chemistry at this Higher Tier GCSE level, while others had difficulty even with core chemical concepts.

The majority of students appeared to have sufficient time to complete the paper. Some used up time and space in extended writing contexts by providing detailed additional information that did not contribute to a fully answered question. In general, the number of writing lines provided is an indication of the length of response expected, though students are of course free to use the blank pages at the back of the booklet if they need to.

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 analysed the information provided, then read and understood the question before writing their response.

The understanding of what is required when responding to command words appears to be improving. It is vital that students understand what the expectations in a response are when a specific command word is used.

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.

There were ten questions on this paper. Questions 1, 2 and 3 were common to the Foundation Tier. The demand levels of the questions are designed to increase from standard demand to high demand through the paper. From question 4 onwards, the demand of each question also increases through the question. As expected, students generally had more difficulty gaining credit in the high demand questions towards the end of the paper. However, the vast majority of students attempted all the questions.

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.

Comments on Individual Questions

Questions 01 to 03 were common to questions 08 to 10 on the Foundation Tier paper.

Question 1 (standard demand)

01.1 Fewer than a quarter of students scored a mark here, with most suggesting incorrectly that no gas at all would escape. The idea of minimising escape was key to gaining the mark.

01.2 The vast majority of students used the main approach on the mark scheme. Around three-quarters of students scored all the marks. Of those who didn't, the majority scored 4 marks by failing to discard the anomalous result in MP1. Weaker responses typically calculated the mean rate of 0.80 cm^3/s but were able to take the process further and gained two marks.

01.3 This closed question was answered completely correctly by two-thirds of students, whilst more than 80% scored one mark. Of these, there was usually a conflict between a factor which would speed the reaction up and one which would slow it down.

01.4 Around three-quarters of the students gained both marks. Uncreditworthy responses usually included the squeaky pop test as a description of the test without reference to flames or burning splints, or described the use of a glowing splint.

Question 2 (standard demand)

02.1 This simple calculation was answered correctly by more than three-quarters of the students. Occasionally errors were seen using 38.9 kJ/g rather than 39.8 kJ/g. In these cases, it was impossible to tell whether this was a transcription error or use of the value for hexanol. Either way, we cannot award credit for transcription errors.

02.2 Nearly 9 in 10 students were able to plot the data within tolerance on all points. However, nearly all drew a line of best fit, which for a discrete variable in this context was not appropriate. These lines of best fit were ignored.

02.3 Around two-thirds of students gained this mark. The answer, within the tolerances stated in the mark scheme, was estimated from the plotted points alone, and was as stated in the mark scheme unless misplotted points (usually for hexanol and/or heptanol) suggested otherwise.

02.4 Fewer than half of students knew that lime water is aqueous calcium hydroxide.

02.5 Around 90% of students could describe the result of this test adequately to gain credit.

02.6 More than half of the students gave a correct response. 'An alkali metal' was a strong distractor.

02.7 This was not well known, with only around 30% scoring the mark. Many students completed a square of bonds around the four atoms provided.

02.8 More than half of the students gained both marks. There was no discernible pattern amongst those who scored one mark.

Question 3 (standard demand)

03.1 This extended response question used the command word 'plan', which was well understood by most students.

A simplistic approach to the level descriptors might be:

Level 3 – will produce the expected outcomes.
Level 2 – might produce the expected outcomes with additions or modifications.
Level 1 – will not produce the expected outcomes.

However**,** the marking of extended response questions must always be holistic, so a best-fit approach must always be followed.

Key steps were shown in the indicative content in **bold**.

In general, most students were familiar with the analytical tests required for this method and wrote coherent plans that would lead to valid outcomes. The flame test for potassium ions was better known.

Many students added value to their responses by describing the use of acid to treat the nichrome wire before use. However, a few omitted to introduce the wire into the flame of the Bunsen burner (as opposed to just holding the wire over the Bunsen burner without stating that the burner was alight) or by using the orange or 'safety' flame for the test.

The halide test was slightly less well known.

Many students assumed that the medicine sample was in solution, and if this was apparent in their response (for example referring to drops of the medicine), this was credited.

Most students added both dilute nitric acid and silver nitrate solution to their sample, although acidification was not strictly necessary as a key step. Some students incorrectly referred to bromine ions, or a slightly incorrect result such as a cream solution. Unfortunately, a very small number of students failed to score any marks at all as despite correctly describing some tests and results, they failed to mention testing the medicine sample and so their methods would not lead to a valid outcome. The minority of students who clearly did not know the tests involved also usually failed to score any marks, as use of reagents and techniques had to be placed in the correct context in order to be creditworthy.

Around 45% of students gave a Level 3 response, whilst more than 20% provided a Level 2 response

03.2 In this question, knowledge of the name of an instrumental method, flame emission spectroscopy, was being tested. The full name was required for the mark. A substantial proportion of students did not know the name of this method. The abbreviation F.E.S. was not creditworthy. Around one third of students gained this mark.

03.3 This question was generally answered well, with 'more accurate' being the most common correct advantage of flame emission spectroscopy given. However, a minority of students answered the question in terms of disadvantages of other methods such as flame tests and this was not creditworthy. Some students suggested incorrectly that this instrumental method was more precise. A few students referred to the identification of multiple ions in a sample, but this was not considered to be a sufficiently creditworthy advantage. More than half of students gained credit here.

Question 4 (**standard and standard / high demand)**

04.1 Around three-quarters of students knew that water vapour is a greenhouse gas. Nitrogen was the most popular distractor.

04.2 Students who gained credit, usually did so by identifying that an increase in population creates an increased demand for energy. There were many references to the increase in the need for transportation in its various (specified) forms, which was creditworthy. However, students often did not gain the second mark as they failed to link the need for more energy to the outcome, that more (fossil) fuels are burned. Some students incorrectly stated that increased respiration by humans has caused the increase in the concentration of atmospheric carbon dioxide. Around 30% of students scored both marks.

04.3 Over half of the students scored both marks. Students who gained only one mark usually did so because they simply stated that more cattle farming causes an increase in methane concentration, but did not explain that this was a result of an increased demand for food.

04.4 This question was answered well, with more than 70% of students giving two effects. Students who did not gain credit often referred to climate change / the greenhouse effect / global warming, without describing the effect.

04.5 Many students gave answers that were too vague, such as there is insufficient data or evidence. The usual creditworthy answers were in terms of previous cooling / warming cycles in the Earth's past. Only around one-quarter of students gained a mark here.

Question 5 (**standard and standard / high demand)**

05.1 Nearly all students correctly identified oxygen as the missing item in the equation and most correctly identified it as a diatomic molecule and were then able to go on to balance it correctly. Four-fifths of students gained both marks.

05.2 This calculation was well done by many students, with more than three-quarters of students scoring the mark. The commonest error was to incorrectly calculate the relative formula mass of the compound due to missing the fact that the compound contained two atoms of sulfur and not one. More than three-quarters of students scored the mark.

05.3 Many students were aware that the test for copper(II) ions produces a blue precipitate. However, there was more trouble in identifying the correct reagent and as a result a number of students scored no marks. A number of students were able to gain credit by the use of a flame test instead. Nearly half of students gained both marks.

05.4 This item was not well answered with many students incorrectly assuming that bioleaching was the same as phytomining. Of those who did know what bioleaching referred to, most were able to identify the use of bacteria, but very few gained the second mark for 'leachate solutions', either just referring to 'leachate', or by going on to say that the leachate contained copper (rather than copper compounds/ions). Only 10% of students scored both marks, although around half knew that bacteria were involved.

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

06.1 Students had a very good knowledge of chromatography and around 75% of students scored two marks for this question. Incorrect responses included references to a lack of a lid and talking about the chromatography paper in general being in the water and not the starting line specifically.

06.2 This was answered extremely well by most and nearly 90% of students scored full marks. Some students used a correct ratio method to arrive at the correct answer. Only a few scripts had no working and the correct answer but there were a number of other incorrect methods used to arrive at the correct answer which therefore scored no marks.

06.3 Students found this question difficult. Many just quoted information from the table, mostly comparing the different distances moved by the dyes on the different chromatography papers. Only a small percentage of students' answers were comparative and they often did not refer to type A and B chromatography paper. Few noted the difference in R_f values between the 2 papers. The compensatory mark was therefore often the only one accessed by students. Many answers were confused involving contradictory ideas. Differences in attraction to the paper was better understood and answered rather than time spent distributed on different papers. So therefore, on the whole, MP2 was accessed more often than MP3. Around 40% of the students gained 1 mark, with higher marks being rare.

06.4 About 50% of students scored 1 mark. Most just referred to using a different solvent, with a few naming ethanol.

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

07.1 The effect of a catalyst on the rate of a reaction was generally well known. Most correct answers referred to the lowering of the activation energy. Many students also referred to the catalyst providing a different pathway for the reaction. References to changes in the number of collisions were insufficient as they did not answer the question. Over one-third of responses gained two marks, and around two-thirds of responses gained one mark.

07.2 Many responses correctly referred to a gas being produced in the reaction. However, as oxygen was given as a product in the stem of the question, if another gas, such as hydrogen or carbon dioxide, was referred to, then the first mark was not awarded. 'The gas was released' was not sufficient for the second marking point but 'being released into the air' or 'released into the surroundings' gained credit. The idea that a gas evaporates from the flask negated the idea of escape in marking point two. Nearly half of the students gained both marks.

07.3 Many students correctly used the tangent to the line drawn in the question to calculate the rate of reaction at 75 seconds.

If the tangent was not used then only MP4 was available for a correct rounding of data obtained correctly from the graph to 2 significant figures. This commonly involved the use of the student reading the y-axis value from a vertical line at 75 seconds.

For the first mark there had to be clear evidence from the graph or data put into the equation, that values for *x* and *y* were chosen from the graph. Some students counted the squares in the *y* and *x* axes and did not score MP1 but the remaining marks were still accessible.

A small number of students added extra calculation steps after evaluating values in an equation. This often meant the second and third marking points were contradicted and therefore those marks could not be awarded.

If *x* and *y* values were awarded but the equation was inverted, only MP1 and MP4 were available.

Over half the students scored all four marks.

07.4 The award of both marks for this question was not often seen. The idea of a line that was less steep than the line given was often credited. However, the second marking point was not awarded on many occasions as the line sketched by the student did not level off at 0.80 g. The link between the only difference between the experiments being a halving of the concentration of hydrogen peroxide solution as the only reactant using a manganese dioxide catalyst was not recognised, resulting in a variety of incorrect responses. The most common answer was for the sketch line to finish at 1.60 g. Around 25% of students scored both marks.

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

08.1 The majority of students correctly circled the C=C group. A common mistake for those who didn't gain the mark was identifying the C-Cl bond or to circle the double bond alone without including the carbon atoms. More than half of students gained this mark.

08.2 There was a wide range of responses to this question. In the majority of answers MP2 was achieved with 3x C-H and 1x C-Cl bonds drawn correctly. Incorrect answers often lacked extended bonds or failed to extend them far enough or failed to replace the C=C bond by C-C.

08.3 A wide range of responses were seen to this question. Common incorrect responses included alloys, polymers, formulations, mixtures and ceramics. Around one-third of students gained this mark.

08.4 A wide range of responses were seen to this question. Common incorrect answers included alkene, hydrogen, named alkanes and alkenes, protein and nitrogen. Around one-half of students gained this mark.

08.5 Many students got this question correct. Those achieving one mark often got this for calculating the M_r of NH_2 and COOH and adding them for MP1. For those who didn't gain any marks a common mistake was subtracting the M_r of NH_2 and COOH from each other. Around three-quarters of students gained both marks

08.6 A wide variety of answers were seen. Incorrect responses included students circling individual side groups such as -OH or $-CH_2OH$ or some including both bridging oxygen atoms or neither. Correct answers varied in which repeating unit they circled – there are six valid alternatives. Nearly half of the students gained the mark.

08.7 The most common correct answers seen were starch, cellulose or glycogen. Polysaccharide was less commonly seen. Incorrect responses included alcohol, amino acids, proteins and a whole range of polymer names including polyester. Fewer than one-third of students gained this mark.

08.8 Many students gave the answer ‘bases’ or gave the names of DNA bases. Fewer than one-third responded ‘nucleotides’.

08.9 The majority of students (9/10) knew the shape of DNA. A common incorrect response was ‘DNA’.

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

09.1 This question was well done by a large proportion of the students. There was an understanding of how to calculate the mass of water obtained from 4.68 g of hydrated copper(II) sulphate and use this to calculate the mass of water from 11.7 g hydrated copper(II) sulphate. The alternative method on the mark scheme was less popular with the students. Over two-thirds of students scored all three marks.

09.2 This question proved to be more difficult for many of the students. It was noticeable that rather than using the value 2.99 g in the calculation a large proportion of the students used 4.68 grams without understanding that the calculation was about the reverse reaction. Just under half of the students gained both marks.

09.3 Around two-thirds of the students gained this multiple-choice mark. Most who did not score selected ‘shifts to the right’ instead.

09.4 Around 40% of the students gained this multiple-choice mark. Most who did not score selected ‘the mixture is a darker shade of brown’ instead.

09.5 Large numbers of the students did not recognise that there were the same number of moles on each side of the equation. Quite a number of students stated that the equilibrium shifts to the side with the least moles and then said that the equilibrium shifts to either the left or the right showing a lack of understanding of the stoichiometry of written chemical equations. Around one-third of the students gained both marks.

09.6 There were a lot of answers relating to the effect of a catalyst on the rate of a chemical reaction without any mention of the effect on equilibrium position. There was a common misconception that increasing the rate of reaction increased the yield of products and therefore stated that the equilibrium shifts to the right. Around one-third of the students gained both marks.

09.7 More than 80% of the students gained this multiple-choice mark. ‘Add more water’ was occasionally seen but ‘leave the reaction mixture for 30 minutes’ was rarely seen.

09.8 This question was not well done. Students appear not to understand what is happening at equilibrium and responses did not relate to the rate of reaction. Around one-quarter of students gained this mark.

Question 10 (standard, standard / high and high demand)

10.1 The command word in this extended response question was ‘evaluate’. Therefore, a reasoned judgement was needed to access Level 3. Level 1 was not used in the mark

scheme because of the level of demand of the question overall. Therefore, simple statements without linkages did not contribute to a creditworthy response.

Many students tried to identify a single fertiliser to be used, so were able to gain little credit. Those who did realise that a mixture should be used were often able to choose A and B, but were less able to articulate sufficient linked reasons. Some focused only on the overall percentage figures, without considering what elements those percentages represented; they treated 'N, P and K' as if it were a single entity or compared the percentage of potassium in A with the percentage of nitrogen in B. Many compared the costs of all three, failing to realise that cost was only relevant when comparing B and C in conjunction with their nitrogen content. Some students confused potassium and phosphorus, thinking P was the symbol for potassium. It was clear that many students had not considered all the information given in the question. Only around 10% of students achieved a Level 3 score of 3 or 4 marks.

10.2 Many students thought the process was phytomining. Others gave the source (rocks) rather than the process. Some gave electrolysis, probably thinking about how potassium is extracted from potassium chloride (even though it is not in the specification) instead of answering the question. Just over one-third of students gained a mark.

10.3 This was quite well answered, with most choosing a suitable potassium salt. Over half of students gained this mark.

10.4 Students found this question difficult and water was about as popular a response as ammonia. There were many students who gave oxides of nitrogen, or elements, or non-existent substances.

Many students seemed to know about the production of nitric acid (even though it is not in the specification) and the intermediate compounds in this process were ignored as the compounds needed are those which feed into the Ostwald Process – ammonia and water. Oxygen is not a compound. Less than one-quarter of students gained the mark.

10.5 Many students realised that the lack of solubility was the issue. There were a lot of answers which went no further than the information in the question, stating that the rock needs to be dissolved rather than it cannot be dissolved, or stating that phosphorus cannot be absorbed from rock without explaining why. Many thought that other toxic or harmful substances might be present. Around one-third of students gained this mark.

10.6 There were very many incorrect answers which attempted to name compounds starting with 'phosphorus'. The answers which were correct tended to split into two camps; those who used their knowledge of fertilisers to name single superphosphate and triple superphosphate, and those who used their knowledge of acids and salts to name calcium sulphate and calcium phosphate. Around 5% of students gained both marks.

Mark Ranges and Award of Grades

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