Questions matter

GCSE
Chemistry

8462/2H Paper 2 Higher Tier

Report on the Examination

8462
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General

Over 120,000 students sat this component, so a wide and varied range of responses was seen.

Many students gave responses which showed thorough and comprehensive understanding of chemistry at this Higher Tier GCSE level. Others had difficulty with basic chemical concepts.

The majority of students appeared to have sufficient time to complete the paper. A few used up a lot of 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 Additional Pages at the back of the booklet should they wish.

Knowledge and understanding of how science works in the laboratory, in industry and in the wider world were tested throughout this paper. This meant that it was essential that students read and analysed the information provided, then read and understood the question before writing their response.

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 nine questions on this paper. Questions **01**, **02** and **03** 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 **04** 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.

Question 1 (standard demand)

01.1 This question was generally well answered by students, with around 60% of the entry gaining both marks.

The specific test and correct result were well known. The most common incorrect responses were a flame not being mentioned and the incorrect flame colour, particularly orange or crimson.

The alternative method of gaining the marks using flame emission spectroscopy was very seldom seen.

01.2 The test for chlorine was not well known. Just over one-third of students gained both marks. If an acid was mentioned it was almost always nitric acid.

Some other tests were chosen with the most common incorrect responses being the addition of barium chloride or sodium hydroxide. A number of students mentioned the test for chlorine gas rather than chloride ions and described the use of damp litmus paper.

The mark for the result of the test was dependent upon a mark being awarded for a correct test.

01.3 Only around a quarter of students were awarded this mark. The use of words such as solution or liquid were common uncreditworthy responses. The removal of **all** the water was also not indicated by many students.

01.4 This multiple-choice question was very well answered, with around 85% of students gaining credit.

01.5 This calculation was generally answered well by most students. Around two-thirds gained all four marks by completing the calculation using one of the approaches given on the mark scheme and usually showing full details of their working. Those who did not complete the calculation usually gained two marks for correctly determining the mean concentration of sodium chloride.

Question 2 (standard demand)

02.1 Around two-fifths of students gained credit on this question. Some students referred to both hydrogen and nitrogen gases being recycled or reused. A few referred to only one of the gases or unspecified unreacted gases.

A number of students referred to excess gases or gases alone. In addition, some students focused their answer on the condenser part of the flow chart and responded with the idea that uncondensed gases needed to be recycled.

02.2 This question was answered well by the majority of students, with roughly two-thirds of students gaining the mark.

02.3 Although this question was answered well, some students referred to a splint being lit initially and then blown out. These students did not often mention the splint was still glowing. The majority of students who stated glowing splint also gained the second marking point. Around three-quarters of students gained both marks; of those who did not, most described the test for hydrogen.

02.4 There were many variations of drawing the arrow for the activation energy. A number of students labelled the activation energy with abbreviations such as E_a. The majority of students correctly named the reactants and products and placed them above and below the lines, with a few using arrows to point out their positions. More than 60% of students gained both marks.

02.5 This multiple-choice question was well answered, with around 70% of students gaining credit. The most popular distractor was that the peak would be lower rather than higher.

02.6 This question was answered extremely well with fertiliser or NPK fertiliser. A small minority stated farming or agricultural use unqualified. Only a handful of students identified its use in explosives or sports injury packs.

Question 3 (standard demand)

03.1 This multiple-choice question proved challenging, with around a quarter of students gaining two marks. However, the vast majority were able to score one mark.

03.2 This multiple-choice question was extremely well answered, with more than 90% of students gaining credit.

03.3 This standard demand item was generally answered quite well. A majority of students had a good overall understanding of the sequence of steps involved in potable water production and wastewater treatment and so scored highly on this item. Weaker responses tended to focus on wastewater treatment, for which the diagram in the stem provided more scaffolding.

Most students recognised that ground water needed to be filtered initially. A few responses referred to screening before the use of filter beds, although only referring to screening in potable water production was considered insufficient. Sometimes the descriptions of things removed by filter beds did not make it clear that they were solid. The process of sterilisation was generally well described, although removal of microbes rather than their destruction was not creditworthy.

Removal of solids using a metal grid was included by most students. Fewer students referred to this step as screening and again things removed by screening were not always clearly identified as solid. Organic matter in sewage is not removed by screening as this is treated subsequently. The final steps were less well addressed overall. Most students referred to sludge and effluent (again these featured in the diagram), but many failed to recognise that these were separated by sedimentation. Some responses confused the separation of sludge and effluent with their biological treatment afterwards. Some students recognised that sludge is treated anaerobically and effluent aerobically but did not refer to digestion or biological treatment or an equivalent description of microbial action.

References to flocculation, desalination, fluoridation or pH adjustment were considered irrelevant and ignored in the marking of this item.

Around a third of students gained a Level 3 mark, with roughly another third achieving Level 2.

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

04.1 Those students who gained marks, mostly did so by stating that the yellow dye travelled further up the page. Fewer students were able to explain that this was due to a weaker attraction between the dye and the chromatography paper. These students did not act on the instruction given in the question to refer to the force of attraction between the dyes and the chromatography paper, instead referring to the relative solubilities of the dyes, or their attraction to the solvent. Around 30% gained both marks.

04.2 Most students gained credit for recognising that the yellow dye travels further in experiment **2**. Those that went on to link this to the relative solubility of the dye in ethanol gained credit for marking point 3. Fewer students explicitly stated that the difference in the distance travelled was due to different solvents being used in each experiment. About a quarter of students scored all three marks.

04.3 Most students considered both dyes in their answers. Students who gained credit usually did so by identifying that dye **A** contained two dyes and dye **B** contained one. However, students often did not gain the first mark as they did not state that dye **A** was impure and dye **B** was pure; instead, they described the dyes in degrees of purity (eg less pure, purer), which was insufficient. Roughly a quarter of students scored both marks.

04.4 This question was well answered and about three-quarters of students were able to gain full marks. Those that didn't gain full marks, commonly didn't gain any credit as they had incorrectly substituted the data given into the equation to calculate the R_f value.

04.5 Only around 10% of students were able to explain the mathematical relationship between the R_f value and the distances travelled by the spot and solvent. Many merely stated that both the spot and solvent travelled further.

04.6 A number of students were able to gain some credit for their answer, with nearly half gaining both marks. Some students incorrectly stated that increased precision was an advantage. Other answers referring to instrumental methods as being more exact, reliable, repeatable, reproducible, efficient or reducing human error were considered too vague.

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

05.1 This was not well understood. Some students knew that nitrogen and oxygen were reacting together. However, some thought that nitrogen came from the fuel and some that oxygen is a product of combustion. Only a minority mentioned high temperature although many said, 'very hot'. About 15% scored both marks.

05.2 Some students stated that no carbon dioxide is produced when hydrogen burns. However, many simply described what carbon dioxide does to the environment, rather than stating that burning hydrogen instead of methane **reduces** the rate of climate change. Many referred to the greenhouse effect without referencing the effect on the environment, ie climate change. Around 40% scored both marks.

05.3 Most realised that increased levels of nitrogen oxides would be produced. Although there were some good descriptions of what nitrogen oxides do to the environment, very few said that those effects would be increased by burning hydrogen instead of methane, ie **more** acid rain etc. Many thought that nitrogen oxides are greenhouse gases rather than a precursor of acid rain. Some suggested more nitrogen was released to the atmosphere, rather than oxides of nitrogen. Less than 10% of students scored both marks, although more than half scored one.

05.4 Over one-third of students gained all three marks. However, some students appeared to believe that the other 80% of the air was hydrogen. Some tried to involve the relative atomic masses, even though these were not provided. A few unnecessarily converted the volume of hydrogen to moles and then the moles of oxygen to volume, not realising that the mole ratio is the volume ratio for gases. This did score full marks if correct.

05.5 Most scored the mark for kerosene, or the vapours condensing, and many also described the temperature gradient correctly. Far fewer scored the mark for linking the height in the column to the boiling point and the condensation of kerosene. Most did not mention the height or level in the column, while others seem to think that a vapour only condenses at a temperature below, rather than at, its boiling point. A few students thought that kerosene was either a product of cracking, or a polymer. Just over 10% scored all the marks.

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

06.1 Most students were able to compare the given data with mathematical processing commonly seen and where the majority of the credit for linked reasons was awarded. Most of the explicitly linked reasons in the indicative content were rarely seen.

Many students thought that burning bamboo to produce heat energy as a method of disposal was a negative point, commonly referring to the release of carbon dioxide as problematic. This was invalid given that bamboo can be seen as a carbon neutral material.

A significant number of students gave comprehensive responses in terms of logically linked reasons but were unable to reach Level 3 because they did not give a reasoned judgement as to which material is better. It is essential that students understand what is required when a particular command word is used, in this case ‘evaluate’.

Around one-fifth of students gained a Level 3 mark, with roughly a further 55% achieving Level 2.

06.2 The idea of a protective oxide coating was scored much more often than the idea of contact between aluminium and water or air or oxygen being prevented.

Common misconceptions were that aluminium has too low a reactivity to react with water or oxygen, that the presence of other metals means that aluminium cannot react with water or oxygen - quite often the idea of sacrificial protection was included – or that iron is the only metal that can corrode. Less than 5% of students gained both marks.

06.3 Greasing, oiling and the use of a sacrificial metal, eg galvanising, were commonly seen. Around three-quarters of students gained this mark.

06.4 A significant number of students gave properties of the components, eg strong, flexible, light. The term ‘matrix’ was seen much more often than ‘binder’. The components of a composite were often reversed. Around 15% of students were awarded both marks.

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

07.1 Around 40% of students scored two marks for this question. However, many students were not able to name the correct reagent for the test. White precipitate was often given as the result of the test, but this answer was not creditworthy unless the correct reagent had been named. Sodium hydroxide and silver nitrate were the most common incorrect reagents. A significant number of students left the answer space blank.

07.2 This multiple-choice question was well answered with two-thirds of students gaining the mark.

07.3 Around 30% of students scored both the marks on this question. Clear descriptions about the numbers of moles / molecules on each side of the equation and the resulting shift in the position of equilibrium at higher pressure were seen. A number of students failed to score the first marking point because they did not give a comparison of the number of moles or molecules of gas on each side of the equation. Answers that focused on changes in the rate of reaction or particle collisions were not creditworthy, nor were those which stated that the equilibrium shifted to the side with lower pressure.

07.4 This question was not well answered and only around 2% of students were awarded both marks. The most common creditworthy responses were based on the idea that a higher pressure is not used because the yield is already high or because more energy would be required to achieve a higher pressure. Many answers could not be given credit because they were not comparative. Higher risk of explosion or higher cost of safety precautions were creditworthy responses that focused on the consequences of using higher pressure compared to using a lower pressure.

07.5 This multiple-choice question was answered correctly by around a quarter of students who used their periodic table to locate and identify vanadium as a transition metal.

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

08.1 Around 60% of students correctly identified the C=C bond. For students who were not awarded the mark common mistakes were incorporating the 3 Hs and 1 O atom attached to the C=C group in their circle or also circling the C=O group. Others circled only the double bond and not the carbon atoms on either side.

08.2 Those students who were awarded marking point 1 used a range of the colours allowed in the mark scheme to describe the starting colour of bromine water. The most common colours were orange or brown. A small number of students described the bromine water as turning clear rather than colourless. For students who were awarded one mark there seemed to be an even split between those awarded marking point 1 and those awarded marking point 2. Just over half scored both.

08.3 A variety of areas in the molecule were circled in an attempt to answer this question. A mistake some students made who were not awarded this mark was incorporating one of the C atoms either side of the ester bond in their circle. Around 40% of students gained credit.

08.4 Those students awarded 3 marks for this question often balanced the equation using half the values of those in the mark scheme and gained credit. A common error was use of inaccurate formulae, particularly a small O on H_2O or CO_2. Just over one-third of students gained all three marks.

08.5 For those students awarded one mark there was an even split between those achieving marking point 1 and marking point 2. A minority of students added atoms or groups to the extension bonds, which contradicted marking point 1. Around 40% gained both marks.

08.6 This multiple-choice question was well answered, with three quarters of students gaining the mark.

08.7 An array of answers were given for this question. Common incorrect responses included condensation, meltable, polyester, hydrocarbon and alkene. ‘Thermoforming’ was regarded as a process and not a description of the polymer used in that process. Nearly half of students gained a mark here.

08.8 Only around 10% of students achieved two marks for this question.

Common mistakes for marking point 1 were referencing crosslinks but saying they were between the polymers or molecules rather than the polymer chains, or mentioning bonds between polymer chains but not stating they were covalent. A number of students also referred to crosslinks between monomers in the polymer or crosslinks between bonds in the polymer.

For marking point 2 many students were not awarded the mark as they gave generalised answers about a lot of energy, or high amounts of energy being needed to break the strong bonds but did not make it clear that **too much** energy was needed to break the bonds between polymer chains.

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

09.1 The idea that gas is lost was well understood but the reason why was less well known. Incorrect responses referred to the solubility of hydrogen in water and faulty apparatus. Around 15% of students gained both marks.

09.2 This question was awarded all four marks to around 20% of the students but a significant number of students did not recognise that the volume of the gas should be converted into dm^3. A small number of students believed that 1 cm^3 = 1000 dm^3 resulting in an answer 10^6 times too large.

09.3 Most students were able to construct a tangent at 45 s. The scale on the *y*-axis posed a problem for a significant number of the students. The calculation of the rate was well done, and most were able to convert their answer into standard form. A small number calculated the mean rate between 0 s and 45 s by drawing a single pair of construction lines which met the curve. Such students were only able to gain a mark for an answer correctly expressed in standard form. Just over half of the students scored five marks.

09.4 The vast majority of the students recognised that the curve started at 0,0 and rose less steeply than the curve shown, but only a minority were able to show that the curve levelled off at 0.0084 mol. Some students lost the first mark by shadowing the existing line for a significant time before becoming less steep. While around 20% of students scored both marks, more than four-fifths scored one.

09.5 This question was quite well done by a large proportion of the students, with nearly half of the students gaining all three marks. The idea that an increase in temperature increased the energy of the particles and therefore increased the rate of reaction was well understood by most students but the increase in collision frequency was less well known. A significant proportion of the students simply stated that there is an increase in the number of collisions with no reference to time. A ‘successful’ collision was considered insufficient to describe particles whose energy of collision exceeded the activation energy.

Mark Ranges and Award of Grades

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