GCSE

COMBINED SCIENCE: SYNERGY

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

8465
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General

There were 9 questions on this paper. Questions 01 and 02 were common with the Foundation tier. The questions are designed to increase from standard demand to high demand through the paper.

Questions 02, 05 and 09 were predominantly set on physics content with the others being set on chemistry..

This paper also contained items targeting mathematical and practical skills.

Students should be advised to clearly show the method of their working when completing calculations. It can be difficult for examiners to credit responses if they cannot clearly follow the method the student has used.

Some students did not make good use of the Physics Equations Sheet supplied with this paper.

Many students seemed unfamiliar with laboratory techniques and equipment. Question 3 was mainly a working scientifically question. There were no items items targeting Required Practical Activities in this paper.

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 two thirds of students identified why metals could be shaped. 'Metallic bonds are weak' was the most commonly chosen distractor.

01.2 Just over half of students gained credit, usually for reference to delocalised electrons. Only just over 20% could go onto give a partial explanation as to how metals conduct electricity, with very few obtaining all 3 marks.

Insufficient responses included:
- electrons being charged
- electrons moving throughout or around the structure

01.3 In this extended response question, the command word 'compare' required students to give both differences and similarities to gain a mark in level 2 (4-6).

About two thirds of the students stayed in level 1 because only differences were listed. Many wrote about individual features but did not pair them and make a comparison.

Several students wrote about the properties of diamond and sodium chloride which were irrelevant in terms of this question and so gained no credit.

About a third of students gained just 1 mark. This was usually for saying that diamond is made of carbon atoms and sodium chloride is made of sodium ions and chloride ions. This information was in the diagram and students should be encouraged to add their own knowledge.

Just under a fifth of students achieved level 2, predominantly with 4 marks.

The most common points from the indicative content which gained credit were:
- covalent / ionic bonding
- strong bonds
- giant structure.

01.4 Nearly four fifths of students gained both marks for the calculation of the relative formula mass of ethene.

01.5 0, 1 or 2 marks were each scored by just under a third of students. About a tenth of students gained 3 marks. The most commonly awarded mark was for the idea that polythene molecules were larger.

Common errors were:
- not giving comparative answers
- using 'it' and 'they' and not referring to a particular molecule so answers were ambiguous
- using 'more' rather than 'larger' molecules
- references to surface area of molecules
- not describing intermolecular forces in terms of strength
- poor terminology such as a lack of clarity about which bonds are broken during melting.

Question 2 (Standard demand)

02.1 More than half of students scored 0 marks. About a fifth gained 2 marks and roughly a quarter gained 1 mark. Mainly horizontal arrows of varying lengths were drawn pointing either left or right. Very few touched the propellor.

02.2 About a third of students gained both marks for ticking all 4 boxes correctly. Three fifths gained 1 mark, usually for the top pair of speed and velocity.

02.3 Although the equation was on the Physics Equations Sheet, recognising the correctly rearranged equation was required to answer the question. Roughly four fifths of students gave the correct response.

02.4 The vast majority of students gained 3 marks for calculating the time taken, with working shown.

02.5 This extended response question required the students to explain what happened to each force shown on the boat after the engine was switched off.

About half of students gained 1 or 2 marks in level 1, a third gained 3 or 4 marks in level 2 and very few reached level 3.

The most common force linked correctly to an explanation was the forward force. Understanding of water resistance, weight and upthrust in this context was poor. Incorrect terminology included ‘forces slowing down’.

Students often discussed the consequences of the engine being switched off. This included descriptions of motion which was not an explanation of what happened to the forces on the boat.

Question 3 (Standard and standard/high demand)

03.1 Less than a quarter of students correctly wrote that the mass decreased because a gas escaped. A common insufficient response was that a gas was produced without saying how that affected the mass.

Incorrect concepts included:

- calcium carbonate dissolving
- gas evaporating
- cotton wool soaking up the products

03.2 About three quarters of students gained 3 marks for this calculation in which the equation for rate calculation wasn’t given within the question.

Incorrect responses usually arose when students were unable to rearrange the equation correctly and calculated 0.0012 × 0.36.

03.3 About half of students were unable to gain credit in this question which required them to explain why a powder reacts faster than lumps. Those who were awarded marks mainly said that powder had a greater surface area but few went on to explain the effect of this.

Insufficient responses included:

- 'more collisions' with no reference to time
- no reference to the acid
- idea of a reaction without specifying contact between the particles.

03.4 About three fifths of students got 3 marks for calculating the total surface area of a cube. A common error was to calculate the volume of the cube.

03.5 Roughly two thirds of students gave an acceptable description of an irregular shape. Insufficient responses usually referred to the lump being too difficult to measure.

Question 4 (Standard and standard/high demand)

04.1 About four fifths of students scored 0 marks with many calculating the energy needed for bond breaking, or the overall energy change. Those who calculated the energy released as part of their calculation could gain 1 mark if 1856 (kJ/mol) was calculated as part of their method.

04.2 Just over a fifth of students identified the reaction profile for an exothermic reaction. The reaction profile for an endothermic reaction was the most common distactor.

04.3 About a third of students gained 2 marks for completing the dot and cross diagram for a water molecule. A quarter got 1 mark and about a tenth did not attempt the question.

Common incorrect responses were:

- six single electrons drawn on the oxygen atom
- only one electon drawn in the overlap
- one electron outside the overlap on each hydrogen atom.

04.4 Less than a fifth of students gained any marks for explaining why hydrogen gas consists of molecules rather than single atoms. Many students made no reference to atoms at all which meant none of the marking points could be accessed. Generally, understanding of the chemistry and the terminology used, was poor.

Common uncreditworthy responses included:

- incorrect use of the terms electrons, molecules and atoms
- references to the nucleus in a hydrogen atom
- references to the reactivity of hydrogen
- reaction with oxygen and the formation of water
- poor understanding of covalent bonding
- the relevance of hydrogen as a gas.

Question 5 (Standard and high demand)

05.1 Students should have worked out the distance represented by each square in Figure 8, counted the squares and then estimated the distance travelled. Very few used this method which is part of mathematical requirement 4f.

Credit was given where students had separated the graph into different areas. This was often one rectangle and two triangles. They then correctly calculated the areas and added them to estimate the distance.

Some students gave no evidence of use of the graph in Figure 8 - without working credit could not be given for their method.

The most common error was to calculate distance = speed x time using values from Figure 8 such as 2.4 × 20.

Other errors included:

- calculating gradients
- drawing tangents.

About an eighth of students gained 3 marks, an eighth gained 1 mark, and the rest scored no marks.

05.2 Nearly three quarters of students gained 3 or 4 marks for calculating the total power output, using and rearranging an equation given on the Physics Equations Sheet. The most common error was not converting 80% to 0.8. Credit was given if 80% was used correctly with evidence of working out.

05.3 About a quarter of students gained 1 mark for saying that the student continued to move forward. However, very few could explain how a seatbelt stopped a student moving with reference to a force in the opposite direction or decelaration.

05.4 This question required the calculation of the initial velocity of the student in the bumper car.

Many students selected an incorrect equation from the equation sheet, usually
$(\text{final velocity})^2 - (\text{initial velocity})^2 = 2 \times \text{acceleration} \times \text{distance}$

Some also wrongly assumed that ‘s’ represented speed in this equation.

Another common error was incorrect or no conversion of 600 ms. This lead to a maximum of 3 marks for those students who clearly showed their working.

Overall about a fifth of students gained 3 or 4 marks and three fifths scored 0 marks.

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

06.1 Less than one fifth of students named bioleaching as the process that uses bacteria to extract metals.

Incorrect responses included:
- bacterialisation
- electrolysis
- fermentation
- oxidation
- phytomining.

06.2 Over four fifths of students gained no credit for this question. Often this was due to a lack of precision in the use of technical terms.

Common errors and misconceptions included:
- omitting oxide and saying that iron loses oxygen
- saying carbon gained oxide not oxygen
- not linking gain or loss of oxygen with oxidation or reduction

06.3 Only about a quarter of students were able to give a reason why some metals cannot be extracted from their oxides using carbon.

This was usually because:
- students often used the words ‘they’ or ‘it’ and the answer was too ambiguous to gain credit
- a comparative was not used when comparing the reactivity of the metal and carbon.

06.4 Only 1 in 10 of students gained at least 1 mark for explaining the use of cryolite. Very few referred to energy.

Incorrect misconceptions about cryolite included:
- speeding up the reaction or use as a catalyst
- lowering the melting point of aluminium not the mixture
- stops aluminium reacting.

06.5 About an eighth of students gained both marks for completing this half equation correctly.

Incorrect attempts included:
- $Al^{3+} + Al^{3-} \rightarrow Al$
- addition of O and Cl
- omitting e^-.

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

07.1 About a third of students gained 3 marks for calculating concentration and giving the correct unit. About a fifth gained 2 marks for the calculation with an incorrect unit. Another fifth got 1 mark, largely for an incorrect calculation with the correct unit.

The most common calculating error was to multiply the two values.

07.2 About half of students got 2 or 3 marks for this calculation using the Avogadro constant.

Common incorrect responses included:

- 1.81 without '× 10^{24}'
- not rounding 1.806 to 1.81
- dividing instead of multiplying by 3.

07.3 Students answered this well with about two thirds gaining all 4 marks.

Several students wrote 52 without showing any working, which should be discouraged.

Students knew to use the periodic table without a prompt. Some incorrectly identified Tellurium which has an atomic number of 52.

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

08.1 Just over half of students gained at least 1 mark usually for stating that the reactivity decreases. Few could go on to explain the trend in reactivity going down Group 7.

A common misconception was that these atoms lost electrons. The correct terms were not used well, for instance, not referring to the electrons being outer electrons, or saying what the nucleus was attracting.

08.2 About a third of students gained 1 mark and roughly a tenth gained 2 marks, usually giving the extra information answers.

Many students gave responses such as calcium loses two electrons or calcium is in Group 2, which were insufficient for either marking point.

08.3 Very few students were able to complete the equation.

About a third gained 1 mark, usually for H_2.

Question 9 (Standard/high and high demand)

09.1 The question required students to explain how a variable resistor can be used to control current and then alter the speed of a motor.

About a third of students gained credit, with the majority gaining 1 mark.

Common errors included:

- incorrect reference to circuit components
- misunderstanding of current
- not linking a changing resistance to a changing current
- saying that the speed of the current changed.

09.2 Under one fifth of students were able to obtain at least 1 mark for explaining why charge only passes in one direction through the circuit. This was usually for identifying the diode and its function.

Very few made a link with alternating current or how the diode works.

09.3 This 5 mark calculation had three alternative methods that could be used to calculate the energy dissipated. Equations could be chosen from the given Physics Equations Sheet.

Students frequently demonstrated parts of more than one method. Responses were often poorly set out with seemingly random and unclear calculations making it difficult to follow the working out.

Less than a fifth of students gained 5 marks. About a third didn't convert the time from hours into seconds and used 2 or 120 as their value of t, but were able to do the rest of the calculation and thus gain 4 marks.

A common mark gained was for the use of $V = I \times R$ to determine the voltage.

Other issues included:

- confusing power and energy
- incorrect rearrangement of formulae
- confusing voltage, current and charge in calculations.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account of 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.