Examiners' Report
Principal Examiner Feedback

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International GCSE Mathematics
4MA1 Paper 2HR

Although this paper contained many questions in a familiar style, testing familiar topics, there were questions, targeted at the top grades, which were especially challenging. It was therefore pleasing to see a significant number of students who displayed commendable prowess in dealing with these questions in the final third of the paper.

Elsewhere students are reminded of the importance of clear, legible presentation of their reasoning as too often mistakes are made through untidy and disordered work. This point is particularly pertinent in those questions requiring several steps to reach a solution or those that require detailed algebraic processes.

Question 1

For many students this question was a source of full marks and probably settled a few nerves. However, a significant number of students did not read the question carefully and failed to appreciate that a *single* transformation was called for. Marks were therefore lost in mentioning words that alluded to translations (move, shift etc.) with or without vectors in moving from triangle *A* to triangle *B*. The centre of enlargement was less well done, (i.e. often missing) with the most common incorrect response being (0,3).

Question 2

This was very well answered with the vast majority gaining full marks. Most students used a factor tree or a table and there were very few arithmetic errors. Those students who did not gain full marks tended to give an answer that wasn't in index form as requested. These gained two marks if they had found all the correct prime factors. Those students who made arithmetic errors could gain one mark if they had at least two correct stages in prime factorisation. Students are reminded that for this type of question working must be shown, as many modern calculators have a FACT facility that produces answers directly.

Question 3

This question acted as a discriminator between those able students and those less so. The latter often took the range of 21cms and added it to what they assumed (incorrectly) to be the shortest height (158cms). They therefore made Candela the tallest person with a height of 179cm. Those who identified that there must be two heights either side of the median made better progress, this meant Candela's height came to 162cms as Alberto's was 158cms. They could then go onto using the range correctly to find Diana's height. A common error elsewhere, involved setting the mean rather than the median to equal 160cms.

Question 4

Those who could remember the difference between the union and intersection symbols usually scored full marks in part (a).

Part (b) required the “No” box to be indicated before any marks could be awarded and then a reference had to be made on the constraints posed by the universal set. Frequently, ‘yes’ was ticked, along with the reason “8 x 3 = 24” or similar.

Part (c) posed the most significant challenge, and many students ignored the condition that each possible set *C* had only 4 members. Multiple correct answers existed here; these included 10, 18 and any two further elements from 9, 11, 13, 15, 17 and 19.

Question 5

The marks awarded for this question regularly covered the entire range from 0 through to 4.

Many students worked steadily through all stages required and achieved maximum marks. However, there were some who did not realize that the side of the square was 6cm, using generally 9cm (from 36 ÷ 4). These students could still gain some credit by applying the formula for the area of a circle or semi-circle provided they remembered to divide their side of the square *ABCD* by two.

There was some confusion on how many circles or semicircles to add to the given area of the square. Some students added the area of four circles.

Question 6

This question comprised of four separate parts and students gained most success in part (a).

Elsewhere marks were lost in part (c) through partial simplification and partial factorisation in part (d).

Question 7

A significant number of students scored no marks for this question as many were unable to see that 4^n needed to be converted to $(2^2)^n$. Popular, but incorrect, answers seen were *k* – *n* (from subtracting the powers on the left hand side) and $\frac{k}{2n}$. The latter earned one mark if it was preceded by the correct conversion of 4^n. For those students who earned the method mark, the vast majority went on to successfully complete the question. A small minority tried to work in powers of 4 but this was usually unsuccessful.

Question 8

The obvious route to success here was to recognize that this was a reverse percentage question and to try to increase the unknown start price by 12% rather than reduce the final price by 12%.

Evidence of a scale factor of 1.12 or 112 led to the awarding of one method mark even if incorrectly used.

Question 9

This was an excellent source of full marks for most students. Those who fell short often failed to put their answer for part (c) into standard form.

Question 10

Many students unnecessarily calculated the length *AP* and used cosine with *AB* rather than notice that the use of tangent with *AB* and *BP* was a more economical method in finding angle *PAB*. Errors in finding the internal angle of a hexagon usually centred around an incorrect use of the formula (n – 2) / n x 180° for the internal angle or confusing the internal angle with the external angle.

Question 11

Not having to calculate cumulative frequency values speeded up the process of answering this question. A small number of students either plotted the cumulative frequency values at the midpoints of the intervals or offered a histogram as an answer for part (a), however both approaches were in a minority. Students are reminded that the question did ask for *evidence* of using the graph in all three remaining parts. Although correct answers within given ranges scored full marks without this evidence, full marks can be given from following through incorrect plotting, provided evidence is shown on the graph of the correct median, upper and lower quartile positions. More thorough students were happy to show this evidence.

Question 12

This question was a good differentiator in that students mostly achieved either no marks or full marks.

There was a relatively easy first mark to be gained by recognising that the scale factor was 5 or 1/5. The majority of students recognised that the method of solution was via similar triangles but failed to match up the corresponding sides correctly. An incorrect approach often seen was $2x / 6 = 1.2 / (2x + 9)$ which generated a quadratic equation. Others who found the correct ratios and generated the correct equation of $2x / 1.2 = (2x + 9) / 6$ were let down later by their algebraic manipulations.

Question 13

This was generally very well done. The most common error was to find the curved arc length but forget to add on the two radii to find the perimeter of the whole shape. A small number of students were confused regarding which of the circle formula to use and opted for the area of a circle / sector instead of the circumference formula.

Question 14

This question posed multiple difficulties for students for a variety of different reasons. Some were side-tracked by the concept of dice and attempted to produce a whole raft of solutions where the denominators were "6". Others did not use their time efficiently and used the whole page to draw a tree diagram with an ever-increasing number of branches. Many produced numerical answers as fractions but omitted to explain their reasoning. A typical answer was 1/16, which gained one mark but the examiner was left in the dark if this represented (say) even, odd, odd, odd etc. The candidate failed to notice that this combination, and others, could be jumbled up in multiple ways. The most economical method was to find the probability of odd, odd, odd, odd (1/16) and subtract this from 1.

Question 15

Many students were able successfully to answer this question by using the area of a triangle formula, area = $1/2ab\sin C$. A few forgot to double this as required to obtain the area of the full kite, and hence only gained the first method mark. Some students were able to either recall or work out that the area of the whole kite would be $ab\sin C$ and obtained the correct solution with very concise working out. Many failed attempts at this question were from students who tried to subdivide into right angled triangles or made the incorrect assumption that *BD* would bisect angle *ABC*. Some students spent time and energy working out the length *AC*.

Question 16

This question focused on the different types of graphs of functions: linear, cubic, trigonometric, and those with asymptotes. About one third of students recognized correctly which functions matched which graphs and scored full marks. If we factor in all students who identified two or more graphs of functions correctly, some two thirds of students achieved at least two marks. Where only one mark was achieved for a correct identification, the answer of C for the linear equation predominated. Of the remaining single correct answer responses, the cubic function (H) proved to be slightly more popular than others.

Question 17

A minority of students did not adhere to using algebra and, as a consequence, scored no marks for this question. Indeed, with less than one in ten students only scoring one mark, the rest were equally divided between scoring no marks, or scoring full marks. Of those who scored no marks, but still used algebra, they invariably started correctly identifying $10x$, $100x$ or $1000x$ as correct recurring decimals but then simply either did not know what to do with their equations or attempted to pair the wrong equations together when subtracting. The most favoured pairings were either 10x and 1000x to reach 342 /990 or x and 100x to reach 34.2 / 99. As a "show that" question, a statement was required that either of these two fractions had to equal 19 / 55.

Question 18

Most students could find the correct bounds of 2.7 to 1 decimal place. It proved more difficult to find the bounds for values rounded to the nearest 5km or to the nearest 0.1 hours. The majority knew that to maximise a quotient you needed the highest numerator over lowest denominator and vice versa to minimise a quotient but often picked inaccurate values. Having found Kaidan's maximum speed and Sonja's lowest, the final mark was for confirming that Kaidan could have the higher average speed. A few students decided that Kaidan was incorrect, and could have a lower average speed, thus contradicting the statement in the question.

Question 19

As we approached the final third of the paper this was probably one of the last questions that was a good source of marks for a majority of the students. Provided students realised that fg(x) was a composite function and not a product, it was usually a straightforward process to find the two critical values for x. At this stage replacing an inequality with an equation was not penalised. Losing the final mark was usually down to choosing the incorrect critical region with $-3/2 < x < 1/2$ offered by many.

Question 20

Students who were successful here started by drawing a reasonable diagram to visualise the problem. Stepping forward from centre *O* to point *A* found the gradient of the diameter. Stepping the same horizontal and vertical units backwards from *O* found point *P*. A follow through mark was available to those who found the gradient of the diameter incorrectly but used the correct method $m_1 \times m_2 = -1$ to find the gradient of the tangent.

Question 21

Many students approached this question correctly by substituting the rearranged linear equation into the quadratic; $x = 3 + 2y$

They continued with varied success with 3 marks being commonly achieved. Here many students, in solving a quadratic in y, used the quadratic formula and stated that their solutions were x values. They then ran into problems substituting these values into wrong places of the linear equation. Others lost their final accuracy mark for not correctly pairing the results for "x" and "y".

Question 22

Numerical solutions to part (a) were common though not necessarily correct. In part (b) a majority of students opted out and left the answer space blank.

Question 23

This was a demanding question, which needed a high degree of accuracy and fluency with algebraic fractions in order to obtain a fully simplified answer.

It was pleasing to see that most students attempted this question, although some with a greater degree of success than others. In general, the most successful approach was by those students who realised that the subtraction in the bracket could have a common denominator of $x^2 - 36$, and that it was not necessary to have a cubic denominator. Through sign errors, or errors when collecting terms when expanding brackets, only a small number of students were able to end up with $8 - 2x$ on the numerator. Of those that reached this point, far fewer noticed that $4 - x$ could cancel with $8 - 2x$ allowing them to obtain the fully correct simplified answer.

Question 24

This question was a good discriminator for students aiming for the top grade. Complete and accurate answers were rarely seen on this question. Those who did achieve full marks were the students who were able to structure their thinking and presentation well.

It was an obvious help that formulae needed for equations were given on the formula sheet.

The majority of responses correctly identified the volume of a hemisphere but those who did not halve the volume of a sphere limited their maximum score to one mark for finding the area of the frustum.

The frustum caused problems for the majority of students, the most common error involved failing to square the radius of the large cone (kr) term leading incorrectly to kr^2. Those who did find correct expressions for shape *A* and shape *B* usually set up the correct equation although many used $B = 6A$ rather than the required $A = 6B$.

The majority of responses that reached a correct equation did not demonstrate the algebraic manipulation needed to collect the *h* terms on one side of the equation correctly and factorise. It was a feature of this question that few recognised that with cancellation of pi's and/ or r's and /or 1/3 earlier in the process would lead to a much shorter, simpler equation to manipulate. Indeed, many left a final accurate answer in unsimplified form.

Question 25

This vector problem was found to be a difficult question, and only a very small number reached correct numerical values for λ and μ. Some were able to pick up one mark for (say) ***AK*** = λ**a** and go further by finding vector equations for ***KL, LM,*** or ***KM.*** The step thereafter was beyond almost all in recognising that ***KL, LM,*** and ***KM*** were all heading in the same direction and therefore the coefficients of **b** divided by coefficients of **a** were equal. Therefore, equations could be formed leading to solutions for λ and μ. For many students the concept of using Greek letters was unfamiliar and added to their confusion. Credit was given to candidates who misunderstood the initial ratios in the question and worked on the basis that *AK:KB* = λ:1, rather than *AK:AB* = λ:1 as given in the question. These candidates could gain all three method marks, but it did make the vector expressions even harder to simplify and manipulate.

Summary

Based on their performance in this paper, students should:

- be able use formula given on formula sheet correctly
- make sure that their working is to a sufficient degree of accuracy that does not affect the required accuracy of the final answer
- make their writing legible and their reasoning easy to follow
- check answers, by back substitution, wherever possible and ensure that the answers arrived of a reasonable size with the requirements of the question

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