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Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2023

Pearson Edexcel International GCSE
In Mathematics A (4MA1) Paper 2HR

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Publications Code 4MA1_2HR_2306_ER

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4MA1 2HR
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The paper was accessible to all students with a good amount of working shown over most of the paper. Some questions, towards the end of the paper, were not as well answered by students but this was due to the differentiation and ramping of the questions.

This is a paper that requires the use of a calculator and students are expected to have access to and use a calculator. There is evidence that some students continue to try to use written methods even when they have a calculator, and this can take longer and also lead to inaccurate answers.

Students should carefully read both the numbers used in the questions and their own handwriting; inaccurate reading leads to inaccurate answers and will mean students lose marks unnecessarily.

Students were less successful with trigonometry (Q9), writing inequalities from a graph (Q8b), finding and comparing the interquartile range (Q14) and using ratios in areas and volumes (Q24).

There were some instances where students failed to read the question properly; an example being question 23. Here some students either did not realise they had to use the formula for the sum of an arithmetic series, but instead used the formula for the nth term.

Finding probabilities in a context and using conditional probability, intersecting chord theorems, arithmetic sequences and manipulation of algebra in later questions, proved to be challenging for many. Reverse percentage in a context, (Q6b) also caused difficulty for less able students.

Generally, problem solving and questions assessing mathematical reasoning were tackled well at the beginning of the paper.

Comments on individual questions

Question 1

(a) A majority of students gave fully correct answers to this part of the question. It has to be said that there was a great deal of sloppiness in students' notation when making the substitution and some students failed to write the -5 in brackets. They very often wrote $-5^2 - 4(3)$ or $-5^2 - 12$, with most of these students then going on to use their calculators with little understanding of how to deal with the square of -5 . This resulted in many answers of -37 instead of the correct answer of 13 . Students are advised to put brackets round any negative numbers when working with algebraic expressions involving substitution, both when writing down their working and when inputting any values into their calculator

(b) Generally, this part was answered well, however, a common error was evaluating $-7x + 5x$ correctly. Overall, the errors made were usually down to poor arithmetic skills when dealing with negative numbers. Many students expanded the brackets correctly and then

proceeded to factorise their answer putting $(x + 5)(x - 7)$ on the answer line or even $x = 7$ or $x = -5$

Question 2

Almost all students attempted this question and almost all of those who did, achieved at least one mark. This was generally for finding a multiple of 36. Many students divided their multiple of 36 by 9 and 12 respectively to find the number of packets of pens and the number of boxes of pencils required. Those students who listed multiples and then used 72 or 108 rather than 36 were able to access some of the marks. Many students went on to multiply the number of packets of pens by 7.60 and the number of boxes of pencils by 4.80 thus gaining the correct answer of 44.80. Some students did not find the correct combination of the number of packets of pens and the number of boxes of pencils. A common error was to find 36 and then write down 7.60×36 and 4.80×36 . In this case, only 1 mark was awarded as the students did not find the correct combination of number of packets of pens and the number of boxes of pencils.

Weaker students embarked on methods to find the individual cost of a pen and/or pencil which ultimately led to no marks.

The methods shown by some students were sometimes confused, but examiners were able to credit sound working where this was shown. Again, this highlights the importance of showing working.

The correct answer on the answer line was often left as 44.8 without the zero which, although wasn't penalised here, is not good practice when dealing with money notation.

Question 3

Most students understood that to work out the average speed, the distance of 515 km had to be divided by the time. However, some students converted the time in hours to 198 minutes, and used this in their calculation, not taking note of the fact that the answer had to be in km per hour so that $\times 60$ was omitted. In general, students that kept units in hours were more successful at obtaining full marks. Others struggled to convert the given time of 3hrs 18 mins to hours with 3.18 being a common incorrect time used.

Question 4

Most students were able to gain M1 by recognising that the sequence decreased by 7 each time and hence wrote $-7n$ as part of their answer. Some students wrote $-7n + 38$ or even $n - 7$. Other students did understand that the correct expression was $-7n + 45$ but wrote their answer with a variable n on both sides of an equation as $n = -7n + 45$, losing the accuracy mark in the process. Some students used the formula for the n th term of a sequence and credit was given if their answers were left in an unsimplified form, i.e in the form $38 + (n - 1) \cdot -7$. Students need to be encouraged to check their rule to see if it works for each term in the sequence.

Question 5

Most students appeared to have knowledge of the trapezium formula (it is given on page 2 of the question paper) and were able to apply it successfully, although there were a number who neglected to put brackets round $(170 + 330)$. If these were not recovered at a later stage in

working, no marks were awarded. Students who did not use a two dimensional formula to find the area were penalised and gained no further marks. Students who worked out 60 000 then divided by 10 000 to find the number of hectares, generally, went on to find the correct answer. Students who used a two dimensional formula to work out the area could access the second and third method marks.

Question 6

(a) Many students gained full marks on this question. Most of the students worked out the total pay for the new job and then subtracted 400 from 490 to find the difference of 90 euros. Using the values of 90 and 400, the students went on to find the correct answer of 22.5%.

Some common errors were to write $\frac{400}{490}$ or $\frac{90}{490}$ thus leading to an incorrect answer. Others, with the correct approach, stopped with an answer of 122.5 or 1.225 as they failed to realise what was meant by a percentage increase.

(b) Students answered this question in two different ways – those who used the correct method of division by 0.94 or those who used the incorrect method of multiplication by 0.94. Careful reading of the question would help students realise that the 6% is a percentage of the original price and not 6% of the given salary. Many students made the familiar mistake of simply finding 6% of the new salary and subtracting it, or multiplying the new salary by 0.94 or 1.06

Question 7

(a) This part was well answered by giving an answer of 1. A minority of students wrote down 0 or $\frac{1}{16}$ which gained no marks.

(b) This part was well answered by giving an answer of -6. A minority of students wrote down 3^{-6} as an acceptable answer.

Question 8

There were many successful answers in part (a). Students who gained one mark could separate the x term on one side and the numbers on the other side. These students could rearrange to obtain $-4x > 8$ then divided by -4 but gave an answer of $x > -2$ instead of $x < -2$

In part (b), most students scored some marks on this question. The award of two marks was relatively frequent and shows that these students could correctly identify two of the lines bordering the region, $x \leq 6$ and $y \geq 2$. Students found it difficult to identify the third inequality $y \leq x$.

Many students could not give the inequality signs correctly.

For those that failed to score at all, the most common incorrect answer seen was just a list of coordinates with a complete failure to engage with the concept of boundary lines.

Question 9

Many students could use trigonometry to find the length of side BC or CD . A common approach to find the other side once BC or CD was found was to use Pythagoras theorem to find the other side. Many students gained 3 marks for working out 42.4... and 26.4... Some students could not work out the radius of the cylinder. A common error was to divide 42.4... by 2 rather than 2π thus losing the fourth method mark and not gaining any more marks. Some students divided 26.4... by 2 or 2π thus losing the final 3 marks. Another common misconception was to assume that half of the length DC was the size of the radius.

Question 10

This question was answered well. A majority of students did appreciate that they were being asked to calculate a weighted, or combined, mean for number of kilometres for Sunday. The most successful method involved finding the product of the means for Monday to Friday and then Monday to Sunday subtracting these two answers to obtain 369 and further subtracting 132 to obtain 237. Some students struggled to find the number of kilometres for Sunday with some doing $104 \div 5$ and $127 \div 7$, which scored no marks.

Question 11

It was pleasing to see many students gain 2 marks for a correct simplified expression. Of those that didn't, many were still able to gain 1 mark as their method was partially correct, but one error was made. For some students this question was challenging by not being able to evaluate $25^{\frac{3}{2}}$ correctly. Many students struggled with the numerical term in the denominator, either leaving it untouched, or multiplying 25 by $3/2$ ($=37.5$).

Question 12

This question was well attempted with most students filling all the boxes with a letter, however, only the most able achieved full marks. There was no particular pattern to the confusion that surrounded the majority of students. Many clearly simply guessed.

Question 13

This was a challenging question for many. Those who gained no marks often failed to deal with the total investment (86151.25) and tried to work on the interest alone (6151.25).

The difference between simple and compound interest should be emphasised by centres.

Trial and improvement was often seen but this can only be awarded marks if accurate final answers are reached.

Question 14

(a) Generally, this question was well answered however a disappointing number of candidates did not order the data before attempting to find the quartiles.

(b) Some students did not understand the idea behind interquartile range (IQR) and concluded that Machi was more consistent as he had a higher IQR

Question 15

This question was poorly attempted. Some started by mistakenly calculated the P(tail) to be $\frac{37}{64}$ and then went on to either leave this as their answer, cube this value or multiply it by 3.

Some students tried tree diagrams to reach an answer.

Those who took the correct first step of calculating $\sqrt[3]{\frac{27}{64}}$ and then finding $\left(1 - \frac{3}{4}\right)^3$ inevitably gained full marks.

Question 16

Many students knew the correct process; to rationalise the denominator and sensibly showed how to do this and then showed an unsimplified answer of $\frac{6+2\sqrt{3}}{2}$. However, many students left their answer as this, or did some incorrect cancelling, - failing to appreciate there was one more step to do to get an answer of the required form of $a + \sqrt{a}$.

Errors seen from students in this question included using an incorrect multiplier to rationalise the denominator (typically using $\sqrt{3}-1$ or simply entering the given fraction as a calculation into their calculator and copying the screen display - this approach scored no marks as working was requested).

Question 17

Marks on this question were well spread, but most students were able to start by cubing both sides of the expression and removing the denominator. Expansion of the left-hand side was usually done correctly, but students were then unable to gather the x terms correctly on one side of the expression. Some students made simple errors, such as losing signs or missing out brackets or expanding $y^3(x + 4)$ incorrectly to $yx^3 + 4y^3$. Those who did gather the x terms correctly usually found an acceptable expression for x with relatively few continuing with incorrect cancellation.

Some students, at the start, did not realise that they had to cube both sides and instead squared or cube rooted both sides. The students still could access the second and third method marks as a special case.

Question 18

This was a challenging question, in the sense that external cases of intersecting chords is not commonly set as a question. Students who were well prepared showed their algebraic method clearly leading to a linear equation. Some students could not recall the intersecting chord theorem and tried different combinations to find the value of DC without success.

Some students found the value of 35, and left this as their final answer, thus losing the final 2 marks.

A common incorrect approach was to write $DP \times 12 = 16 \times 14$ or $DP \times 12 = 30 \times 16$ losing all the marks as the method is incorrect.

Question 19

This question was a good discriminator and those who understood the topic normally found a correct answer efficiently and concisely. Many students did not use an algebraic approach when trying to find the value of 8. It was disappointing to see students not setting up an equation and then solving it for their variable. Students who approached the question by using a Venn diagram had some success as they could find the number of adults who booked breakfast and dinner. At this stage, students left their answer as 8 or $\frac{8}{30}$ and did not gain the final 2 marks. Many students found this difficult and could not label the Venn diagram. A common error was to find $\frac{8}{30} \times \frac{8}{30} = \frac{64}{900}$ or $\frac{16}{225}$ thus gaining the third mark and losing the accuracy mark.

Generally, the least able students found it difficult to make any progress at all. Many students failed to realise the probabilities were conditional. Many students tried a trial and improvement approach but rarely succeeded in this way.

Question 20

Where students were able to recognise the application of the 'Alternate Segment Theorem', this question was well answered.

Some creative approaches were seen – for example, involving tangents at right angles to the radius, and the concept of a 'circumcentre' of the triangle. Other approaches also brought in 'Angles in the Same Sector' and 'Angle at the centre' theorems. Whilst it was possible to secure full marks with some of these more complex approaches, it would be worth students noting that the question is worth 2 marks and should work to apply answers that are 'efficiently' worthy of this credit.

Students who clearly had identified angle ACM as being equal to 78 (by seemingly visual inspection), arrived at an angle of 24 degrees for angle BCA (using angles on a straight-line), and were unable to go any further and earned no marks.

Question 21

This was answered very well by students in the target range for the question, with many students gaining 5 marks. Below the target range many were unable to make any meaningful progress, though it was quite common to see the first mark scored for a correct substitution. $(1 + 2x)^2$ was expanded to $1 + 4x^2$ far too often. If a three-term quadratic could not be obtained, the student could not gain any possible follow through marks. Factorisation and the quadratic formula were both used well to solve the quadratic equation. The mark scheme was very generous here and, as a consequence, those students who made minor arithmetical errors were able to score up to four marks if all working was shown clearly. Students who found all x and y values must understand that these must be correct and clearly paired to score the final mark.

Question 22

(a) Three dimensional Pythagoras is always a challenging subject for students, and so it proved again. However, it was good to see many make a good start and gain some credit. A decent number of students were able to complete a process to find BE using Pythagoras. It is worth noting, that at this grade a complete method was required for a single mark, whereas at a lower level we may see 2 marks for Pythagoras.

The common error was to apply Pythagoras' Theorem incorrectly, subtracting rather than adding the squares of the lengths.

(b) Again, students often find 3-D trigonometry challenging and this question was no different. There were a number of correct answers, but a wide range of incorrect responses, where, in many cases, the student found the incorrect angle. Students who made an attempt but did not find the correct angle gained a method mark for the length UR found.

It was also unfortunate that many got the length correct for UR but then got the trigonometric ratio the wrong way round, e.g, they used $\tan x = \text{Adjacent/Opposite}$.

This question was another case where premature rounding could lose the accuracy mark.

Question 23

There were a fair number of blank responses on this high grade question as it proved very challenging indeed, but some students had a go and were often able to pick up a method mark for setting up an equation in terms of p using $U_2 - U_1 = U_3 - U_2$ or $U_1 - U_2 = U_2 - U_3$. This value of p was often erroneously seen as 1 as a direct consequence of missing brackets in the students' attempts at forming an equation in p . However, a large number of students worked out the differences between pairs of adjacent terms, but then failed to equate these and consequently achieved no marks - many did a lot of algebraic manipulation writing an equation in terms of p and d but still achieved no marks. Some students used strange methods to come up with an actual value for p which of course is not possible from the information provided in the question. It was pleasing to occasionally see a perfectly correct response.

This was a question where clear layout was essential. Those students that took care to present their work in a logical way were often successful whereas where working was muddled, students often lost their way and also lost marks they might otherwise have gained.

Question 24

Questions at the latter stages of the paper are graded at level 9 and are designed to be challenging. This was another question that the students found challenging with many students failing to realise that they had to find the linear/volume scale factors and used a factor of 9 throughout earning, as a result, no marks. Many students tried to set up the initial equation but were hampered by the fact that they did not use different variables for the radii of the two spheres. Some students wrote down the scale factor to be 3 or wrote down the scale factor to be 27 for the volume thus gaining the first two marks. For many students, this is as far as they got.

The third mark was only obtained by the most able students as they had to find a **correct** equation based on volumes with only one variable eg R or r or x . This proved very challenging for the vast majority of students.

Question 25

A rough sketch of the line $y - 2x = 7$ as a starting point would have helped, but most students opted not to draw this.

Many students gained 3 marks by stating the gradient of AB to be $-\frac{1}{2}$ and equating this to a

correct quotient containing k and j obtaining $\frac{k-7}{6-j} = -\frac{1}{2}$. From there only the most able

students were able to proceed and gain further marks, usually by forming correct simultaneous equations from a gradient expression and putting the midpoint coordinates back into $y - 2x = 7$ for the fourth method mark, to reach $k = -1$ and $j = -10$ for the fifth method mark.

This tactic would have been more apparent if students had drawn a line, together with its perpendicular bisector to help the visualisation.

Question 26

This question was poorly answered. Only the very best students were able to recognise the transformation of the cosine curve and give the correct values for a , b and c . Finding the correct value of a was not surprisingly a lot easier than the finding the correct value of b .

Summary

Based on their performance in this paper, students should:

- be able use formulae given on formula sheet correctly. Also, to be aware of which formulae are given,
- be able to apply Pythagoras theorem and trigonometry in the context of a problem,
- be able to read graph scales accurately,
- be far more disciplined in their use of brackets and signs,
- read the question carefully and review their answer(s) to ensure that the question set is the one that has been answered and their answer(s) represent a reasonable size,
- 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,
- students must, when asked, show their working or risk gaining no marks despite

correct answers.

