Examiners' Report
Principal Examiner Feedback

Summer 2019

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

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IGCSE Mathematics 4MA1 2H Principal Examiners Report

Students who were well prepared for this paper were able to make a good attempt at all questions.

Students were less successful in applying the formula for area of a triangle to a problem

On the whole, working was shown and easy to follow through. There were some instances where students failed to read the question properly. For example, in question 11c some students did not realise that this is a reverse percentage.

Completing the square, probability, vectors, surds and simultaneous equations (one quadratic and one linear) seemed to be a weakness for many students. Operations involving negative numbers were also a weakness.

Overall, problem solving questions and questions assessing mathematical reasoning were tackled well.

Question 1

Many students answered this question well. The majority of the students showed clear working However, a common error by some students was to use the lower limits or the upper limits to work out $\sum fx$ so gained 2 out of the 4 marks available. This method is incorrect and the students need to understand that they must use the mid points. Other common errors were to write $\frac{5400}{\text{their freq}}$ (students should note that the value of the sum of the frequencies was given in the question) or writing $\frac{5400}{5}$. A common error was to multiply the frequencies by the class width (10).

Question 2

Students need to ensure they use a sufficiently dark pencil for their work to be visible.

A multitude of triangles, circles etc around the line *DE* were offered by a minority of students who had no idea how to proceed. Others who produced one pair of intersecting arcs and then used a protractor to draw the bisector scored one mark A number of students drew a pair of touching circles centered on *D* and *E*. Arcs of the same radius, from *D* and *E*, above and below the line *DE*, clearly intersecting, were needed to secure the first mark. Pairs of parallel arcs above *DE* only and then joined up to extrapolate down to *DE* scored one mark. In a minority of cases students produced two arcs at an equal distance from *D* and *E*, intersecting the line *DE*. The required intersecting arcs were then constructed from these two points and this was accepted as a valid method. Some students lost a mark where they had the correct intersecting arcs but failed to draw in the line.

Question 3

In Q3(a) majority of the students were able to give a satisfactory explanation. However, some students simply explained what the notation meant rather than answer the question. All that was required in Q3(a) was a simple response of the type 'There are no members are in both *A* and *B*', '*A* and *B* have no members in common' etc. Unfortunately, some candidates tried to give too much information and ended up with an incorrect or contradictory statement. Some candidates clearly didn't understand the terminology and gave statements about the total of the numbers in A and B not equaling the total of the numbers in the Universal Set, or they made incorrect comments about odd numbers in one set and even numbers in the other. Some tried to distinguish the two sets by stating that the elements of A were prime whereas those of B were even but failed to comment on the value 2. However, the responses were generally well written and showed understanding.

In Q3(b) the correct numbers 1 and 9 were given thus gaining the one mark.

In Q3(c) three of the four numbers were seen with an incorrect additional number or as incomplete answers that were worthy of the award of one mark. Some students simply wrote 4 or 5 or 6 numbers or omitted this part completely, indicating a lack of familiarity with set notation. Some attempted the question by drawing an incorrect Venn diagram. If candidates had used a correct Venn diagram they often gained all the marks.

Question 4

A majority of students gave correct answers. Those who gave the incorrect answer often used the formula incorrectly by not squaring the radius. A few students used the diameter instead of the radius in an otherwise correct formula. Some squared π instead of the radius. Many candidates who gave a correct value such as 3079 went on to write it as 308 (correct to 3 significant figures).

Question 5

In Q5(a) the majority of students gained some marks by working out the total cost of the 120 books and then working out the cost of the books that cost £5 each. Many students could work out the total cost of the three different types of books as £732, however, some students misinterpreted this part. When working out the number of books that cost £7 each, a common error was to find 40% of 60 rather than 40% of 120, and then use this value to find the number of books costing £8 each. This method gave a common incorrect answer of 57.5%, and students doing this then lost the final 3 marks. Another common error was an attempt to work out the percentage profit. Some students worked out 152.5 and then did not subtract from 100 or work out 0.525 and then did not multiply by 100 so losing the final 2 marks. Some students, having calculated the profit correctly, were unsure which value they had to compare it with, often choosing the incorrect one of 732.

In Q5(b) students answered this question in two different ways – those who used the correct method of division by 1.2 or those who used the incorrect method of multiplication by 1.2. Careful reading of the question would help students realise that the 20% is a percentage of the original price and not 20% of the given price. Many students made the familiar mistake of simply finding 20% and subtracting it, or multiplying by 0.8

Question 6

The majority of students gained all marks in this question but for a few candidates at the first appearance of a triangle in the exam paper they decided that it must be Pythagoras Theorem and gained no marks!

Many students produced completely correct solutions to both parts of this question on proportionality, although others either made no attempt or tried to use Pythagoras' Theorem.

In Q6(a), scale factors were the most popular approach, usually $DF = 4.2 \times 2.5$ but sometimes

$DF = 15 \times 0.7$.

In part (b), scale factors were still widely used but proportionality statements such as $\frac{BC}{19.5} = \frac{6}{15}$ also appeared regularly. Scale factors were sometimes used incorrectly, multiplying instead of dividing, for example, or used with 19.5 or 4.2 to find *BC*.

Question 7

This question was answered well. A majority of students did appreciate that they were being asked to calculate a weighted, or combined, mean for the test marks for the girls. Many students worked out the total marks for the boys and the total test marks. Some students did not know what to do from here and thus gained only one mark. A majority of the students worked out the difference and divided by 17 and gaining full marks.

A common error here was to simply find the arithmetical mean of the given means (25.9). Another common error was to assume that the overall mean [26.8] was simply the average of the boys' mean (25) and the girls' mean (*x*), so that $\frac{25+x}{2} = 26.8$, giving $x = 28.6$. Some students lost the accuracy mark by writing an incorrectly rounded answer without writing the unrounded answer first. There was evidence of poor arithmetic with candidates writing 30 – 13 = 7

Question 8

This question was not answered well by the majority of students. Many students cannot recall that there are 1000metres in 1 kilometre or 3600 seconds in 1 hour. Many students were put off by x as they are used to seeing a number to convert. A common approach was to choose a number and then multiply by 1000 this gaining one mark. Students need to recall how to convert hours to seconds. Several students knew that 1000 and 3600 (or 60×60) were to be used, but multiplied instead of dividing and vice-versa. A common misconception was to work out $1000 \times 60 \times 60 = 3600000$ and state an answer of $3600000x$ without stopping to think what such an answer implies.

Question 9

Many students answered this question well and showed a clear method. Some students made simple arithmetical errors, however, and several students did not know whether to add or subtract the two linear equations. Errors of the form $6y - (-y) = 5y$ were sometimes seen. Students had to start with an algebraic method leading to a correct equation with one unknown to gain the first method mark. The awarding of the accuracy mark was dependent on gaining the first method mark. Correct answers by trial and error or using a calculator were rare but gained no credit.

The elimination method still seems to be the favoured method, but a number of students who set up their equations as: $3x + 6y = -1.5$ and $3x - y = 16$ were much more likely to make an arithmetical error in the subtraction to eliminate x than the students who chose to add $x + 2y = -0.5$ and $6x - 2y = 32$ to eliminate y. Many students lost marks because of errors involving negative numbers.

Question 10

Q10(a) was done quite well. Many students were able to use the given gradient and the intercept on the y-axis to correctly write down the equation of the straight line. A common and perhaps surprising error was to omit "y" when writing down the equation of the straight line, eg $5x - 3$ or $L = 5x - 3$.

In Q10(b) there was evidence of x and y being confused in answers to this question. Similarly, the wrong inequality signs were often seen with = used instead of the correct $\geq$ and vice versa. In particular, students could not use pairs of inequality signs, so attempts such as $1 < y > 3$ were seen. Incorrect values were occasionally read from the axes with -2 being used in place of 2 when writing down the inequalities in x being the most common of this type of error. 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 11

This question was intended to test the use of a calculator with standard form, so it is disappointing to see students laboriously writing out the values in full before going on to do their calculation.

In Q11(a) a number of students used the values in standard form in the table to work out the difference leading to a correct answer. Some students converted the standard form numbers into ordinary numbers before subtracting. This ran the risk of miscounting the number of zeros. Some students left the final answer as 6750 or 675 000 and this lost the accuracy mark. A common loss of the final mark was giving the answer as 67 500 and not in standard form.

In Q11(b) the students had three routes to work out the answer. The first route was to find $(8.3 \times 10^3) \times 50$ resulting in an answer of 415 000 or 4.15×10^5 to gain the first mark but students lost the final accuracy mark for not comparing 415 000 with 42 000 or for not comparing 4.15×10^5 with the value in the table. Similarly, the second route was to find $(4.2 \times 10^4) \times 50$ resulting in an answer of 840 or 8.4×10^2 to gain the first mark but students lost the final accuracy mark for not comparing 840 with 42 000 or for not comparing 8.4×10^2 with the value in the table. The third route was the most common as the students worked out $\frac{4.2\times10^4}{8.3\times10^3} = 5(0.60....)$ and comparing with 50 and stating 'No'.

In Q11(c) the majority of candidates scored either full marks or no marks. Many of those who scored full marks used the product of multipliers 1.15 × 0.92 or an equivalent expression, while others nominated and used an initial cost of a ticket. Those who used this approach sometimes lost the final mark by failing to divide the initial cost of the ticket from the answer. Many students gained one mark for 1.058 or 105.8.

Question 12

There were many successful methods which gained full marks. The majority of these comprised finding the length of *ED* $\left(\frac{16.7}{\tan 43}\right)$ and/or working out the length of *CD* $\left(\frac{16.7}{\sin 43}\right)$

For those who used this approach, some students lost marks by rearranging incorrectly and expressions such as $ED = 16.7 \times \tan 43$ or $CD = 16.7 \times \sin 43$ was were often the problem.

Some students used a two step method using *ED* $\left(\frac{16.7}{\tan 43}\right)$ and then $CD=\sqrt{16.7^2+'17.90....'^2}$ or *CD* $\left(\frac{16.7}{\sin 43}\right)$ and then $ED=\sqrt{'24.48....'^2-16.7^2}$ ran the risk, inherent in all circuitous methods, of loss of accuracy in the answer due to premature approximation at some stage. Another method consisted of finding the length of *ED* and *CD* using the Sine Rule. There were many variants on these two basic strategies. It was not unusual to see the Sine Rule used, unnecessarily but usually accurately, in right-angled triangles. Working was often easy to follow but some attempts provided a challenge to markers, especially when they covered all the available space. Their task was made more difficult by the ambiguous labelling of sides. A common error of in finding the perimeter was to include 16.7 twice in the method which gave an incorrect answer of 118.2 thus losing the final two marks.

Other errors of no worth was to find the area of the triangle *CED* and the rectangle *ABCE* or even the area of the trapezium *ABCD*.

Question 13

In Q13(a), the cumulative frequency table was completed accurately by the majority with very few errors seen.

In Q13(b), the plotting of the cumulative frequencies was extremely well done, with the majority plotting end points accurately and joining with a smooth curve or line segments. Very few plotted mid points and only a very small number of students drew a 'squashed' cumulative frequency curve. A very small number drew histograms or bar charts or a line of best fit.

In Q13(c), most students were able to gain the mark for the median. It is important that students show clearly the method that they used to find the median.

In Q13(d) fewer students were successful in finding the interquartile range. Some who drew lines at 20 and 60 and then drew vertical lines from the cumulative frequency diagram then misread the scale on the horizontal axis. It is important that candidates show clearly the method that they used to find the inter quartile range. Many candidates failed to read the scale correctly, writing their values on the horizontal axis would help with clarity.

Question 14

Most students who showed some understanding of vectors generally by working out the column vectors $\begin{pmatrix}5\\-12\end{pmatrix}$ or $\begin{pmatrix}-5\\12\end{pmatrix}$ but were unable to offer a correct method for finding the magnitude of $\overrightarrow{AC}$ – possibly due to some unfamiliarity with the word 'magnitude'. It was disappointing to see some students adding the vectors such as $\begin{pmatrix} 6 \\ -9 \end{pmatrix} + \begin{pmatrix} 1 \\ 3 \end{pmatrix}$ giving a common incorrect answer of $\begin{pmatrix} 7 \\ -6 \end{pmatrix}$.

Question 15

Marks on this question were well spread with less able students struggling to start. A large number of students were able to square both sides of the equation and remove the denominator, and expand the left-hand side correctly but were then unable to gather the x terms correctly on one side of the equation. Some students made simple errors, such as losing signs or missing out brackets or expanding $y^2(x + 1)$ incorrectly to $yx + y$ or $y^2x + y$. Those who did gather the x terms correctly usually found an acceptable expression for x with relatively few continuing with incorrect cancellation. Generally, many students were able to manipulate the denominator and then failed to get the second method mark because they incorrectly expanded the brackets/executed the multiplication.

Question 16

Marks on this question were well spread with less able students struggling to start. Many students did write down a correct expression to multiply both numerator and denominator by the same correct expression. $\sqrt{2}+1$ was the expected choice but a surprising number used $-\sqrt{2}-1$ instead. Although a significant number of candidates multiplied by $\sqrt{2}-1$ they then usually obtained 1 (or −1) in the denominator. The more able students were able to expand the numerator to obtain 4 correct terms. Some students did not correctly simplify the numerator so lost the final accuracy mark. This was a challenging question.

A significant number of students used their calculator to reach the answer straight away, and if they did not show the steps of the working, as requested in the question, they scored no marks.

Question 17

Students’ ability to deal with proportionality questions has not really improved over the years. They show little confidence in the setting out of the steps to find the value of the constant and the presentation of their work is often poor and very confused. For the values of y and x to each involve a variable was a step too far for many.

In Q17(a) the students who used the correct initial formula $y = kx^3$ generally went on to score full marks in this part of the question. Some students misread the question as they worked out that $k = \frac{20}{h^2}$ or $k = \frac{20h}{h^3}$ and then wrote the final answer as $y = \frac{20}{h^2}x$ or $y = \frac{20h}{h^3}x$ as the question said write down the formula of y in terms of x and h. Some candidates were confused over whether h was a constant or a variable, so instead of writing $20h = kh^3$ they wrote $20x = kx^3$ and became completely confused.

In Q17(b) students generally answered this part well if they answered Q17(a) well. Although some students omitted to take the cube root and hence lost a mark.

Question 18

This question produced a wide variety of responses from students of all abilities. Even the more able candidates sometimes lost some of the available marks. A number of students were able to identify the key starting point and used the given shape to deduce that the area could be expressed as $x^2 + x^2 + 4x(12 - 3x)$. Nearly all who went this far then manipulated the expression into the required form of $48x - 10x^2$. Common errors at the start were to assume that the shape was a cube so that $x = 12 - 3x$ which lost all the marks in the question. Some assumed that each side had an area of x^2 or $x(12 - 3x)$ which just gained the first mark. A minority of students tried to start by finding the volume of the cuboid, by multiplying together the three given dimensions; this gained no credit.

Many students did not understand that the question involved differentiation, those who realised that they had to differentiate usually did it accurately and obtained full marks. Some students who obtained $A = 48x - 10x^2$ then decided to divide this by 2 and thus writing $A = 24x - 5x^2$ and then differentiated.

Students who did differentiate correctly tended to equate the derivative to zero and obtain the correct value of x. Using this correct value of x they then obtained the correct maximum area of 57.6 Many students assumed the shape was a cube and multiplied $x(12\text{-}3x)$ by 6.

Many students used completing the square successfully on this question, often gaining full marks.

Question 19

This question produced a wide variety of responses from students of all abilities. This question was targeting the more able student and many who are used to similar calculations made a very good attempt with the correct answer being seen a pleasing number of times. Those who did not start by using the area of a triangle to find *AC* failed to make progress. Those who did, could often find the length of *AC* and then progress to find the length of *AB* or *BC* by using the sine rule. However, some who could use the formula $\frac{1}{2}ab\sin C$ misidentified *b* with the wrong side. Some students just found the area of triangle *ABC* and forgot to add the given area of 250

Some students tried a right-angled triangle method to find sides and angles, although none were given on the diagram or stated as right angles and this method failed to deliver any marks. Some students used the idea that opposite angles added up to 180° confusing themselves with cyclic quadrilaterals.

Question 20

These types of questions come up frequently and students generally know what is required. The students sitting this paper were no exception, most of them showing clear algebraic working and gaining a set of correct answers. Those who didn't gain full marks generally gained 1 mark for showing a correct substitution but were unable to expand the bracket correctly, or 3 marks for getting to the correct three-part quadratic but being unable to solve it by either factorisation or use of the formula. Many students made algebraic errors whilst trying to eliminate one of the variables or in the resulting algebraic manipulation after a successful elimination of a variable. One of the most common was to expand $-3x(9 - x)$ as $-27x - 3x^2$. Another common error was to expand $(9 - x)^2$ as $18 - 18x + x^2$. A few insightful students rewrote the quadratic equation as $(x - y)(x - 2y) = 0$ and then (correctly) stated that $x = y$ or $x = 2y$ from which the solution to the simultaneous equation easily followed.

Where there are two pairs of solutions students should ensure that they correctly pair the values of *x* with the values of *y*.

Question 21

Students often find 3-D trigonometry and Pythagoras challenging and this question was no different. It was pleasing to see a number of correct answers, also saw a wide range of incorrect responses, where, in many cases, the student found the incorrect angle. Students' labelling of angles was sometimes confused, with a lack of clarity about which sides and which angles were being calculated. Students who made an attempt but did not find the correct angle often gained a method mark for *AC* or *AF* found. Several students started by using Pythagoras to find *AC* and then used this to find *AF* even though they didn't need to. It was also unfortunate that many got the length correct but then at the end got the trigonometric ratio the wrong way around e.g. they used tan *x* = adjacent ÷ opposite.

This question was another case where premature rounding could lose the accuracy mark e.g. $\sqrt{20}$ rounded to 4.5 There was evidence of poor algebraic notation where students wrote $2x^2 + 4x^2$ instead of the correct $(2x)^2 + (4x)^2$

Question 22

Some students started to incorrectly cancel out values from the numerator and denominator without factorising, often gaining a numerical answer. For those that realised the need to first factorise the numerator and denominator, it was most common to gain the method mark for the denominator as many correctly factorised the denominator to $(2x + 5)(2x - 5)$. Many students clearly struggled to factorise $6x^3 + 13x^2 - 5x$. Some students realised that x was a factor of the numerator and then wrote their expression as $\frac{6x^2+13x-5}{(2x+5)(2x-5)}$ thus losing the final two marks. Others who kept the x in factorised $6x^2+13x-5$ as $(3x+1)(2x-5)$. If a student successfully factorised the numerator and denominator they generally gained full marks, by then correctly cancelling $(2x + 5)$. However, some students gained the correct answer and then simplified further incorrectly so lost the accuracy mark.

Question 23

The instructions contained in this question were to 'Show your working clearly.' Thus, a correct answer without any correct supporting working scored no marks. Students found it very challenging to set up the equation $\frac{3}{t}\times\frac{t-3}{t-1}+\frac{t-3}{t}\times\frac{3}{t-1}=\frac{12}{35}$ or an equivalent version. Many students missed out one of the two products in the equation. Some of those students who formed the correct equation were then unable to rearrange this correctly into a quadratic equation without fractions that could be easily solved. One error was to multiply through by $t(t-1) \times t(t-1)$ to get an equation which was too difficult to solve. Others equated the numerators to get $6t - 18 = 12$. Many students did not recognise that algebra had to be used to make progress with this question and thus gained no marks.

Question 24

Q24(a) was well answered.

Q24(b) was poorly attempted by the students. Only the most able mathematicians were able to secure a correct answer. The majority of students did not know how to start the question and thus could not gain any marks. Those who knew how to find the inverse of a function sometimes found the algebraic techniques required too challenging, particularly by using the method of completing the square. Some students gave an answer of $5\pm\sqrt{\frac{x+41}{2}}$ not realising that only the positive answer was required as $x \geq 5$. Unfortunate errors included $2x^2 - 20x + 9 = 2(x^2 - 10x) + 9 = 2(x - 5)^2 - 25 + 9$. Some misinterpreted $x > 5$ as a cue to solve a quadratic inequality.

Summary

Based on their performance in this paper, students should:

- Be able to understand the meaning of magnitude of a vector
- be able to recall and manipulate the formula $\frac{1}{2}ab\sin C$ for the area of a triangle
- be able to interpret set notation
- read the question carefully and review their answer to ensure that the question set is the one that has been answered
- make sure that their working is to a sufficient degree of accuracy that does not affect the required accuracy of the answer.
- Students must, when asked, show their working or risk gaining no marks for correct answers

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