Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2024

Pearson Edexcel GCSE (9 – 1)
In Mathematics (1MA1)
Higher (Non-Calculator) Paper 3H

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GCSE (9–1) Mathematics 1MA1
Principal Examiner Feedback – Higher Paper 3

Introduction

Students generally were able to attempt many of the questions in the time available and to demonstrate their understanding of many of the topics that were being tested. It appeared that most students had been entered appropriately for the higher tier and as expected the first part of the paper was very well answered. Student's solutions were generally clearly and logically presented; this should be greatly encouraged as clear work and showing method and processes means that students have an increased access to marks, particularly those questions where the mark scheme allows for follow through of an incorrect value in the awarding of subsequent process marks (as denoted by square brackets in the mark scheme). There were a significant number of potentially avoidable errors and misreads with this paper, in particular with the number of zeros in question 4 and the omission of the .14 on question 14.

All questions were accessible to some students. Questions 1, 2, 3(b), and 6(a) were answered successfully by most students whereas questions 18, 20(b) and 21 attracted fully correct solutions from only a small proportion of students. Questions 3(a), 10, 14 and 16(b) appeared to challenge a significant number of students working at the targeted attainment level. To balance this, it was encouraging to see more students than expected get at least some marks for their answers to questions 11, 18, 19 and 20(a).

Given that this is a calculator paper, we still saw too many students seemingly not using a calculator when appropriate, or not using efficient calculator methods. For example, when calculating percentages, some students spent valuable time working out calculations by hand, such as 3.5% of a quantity, rather than inputting this into a calculator.

Whilst methods may have been learnt, students are still struggling applying that knowledge to those questions with a problem-solving element. We would encourage students to carefully read each question. All the information needed to answer problem-solving questions in particular, are presented in the text.

Report on individual questions

Question 1

Most students were able to score at least one mark normally for a correct factor tree for 63 or 105 with no more than one error. Although one error was condoned here, it was pleasing to see that most factor trees were accurate. Quite often a correct Venn diagram was drawn for one mark, though many were unable to use their Venn diagram to arrive at the solution required. Very common incorrect answers given were 3 and 7 and these gained one mark; an answer of 7 x 3 also just gained the one mark. The method mark could also be gained for listing factors of 63 or 105. Although many students gained full marks, a significant proportion chose the LCM of 315 rather than the HCF of 21. It was disappointing to see that some Higher Tier students showed that they did not fully understand the difference between factors and multiples and gained no marks for just listing the multiples.

Question 2

A high percentage of students showed a good understanding of standard form.
In part (a) nearly all students were able to convert from the numbers in standard form to ordinary numbers, although it will be of no surprise that (ii) was answered less well than (i). Most students were able to use their calculator to work out the value of the calculation in part (b) and get, 34 200 000. These students scored at least one mark, but many of them were not then able to write the number in standard form, despite being able to convert from standard form to an ordinary number in part (a). Of those that gained no marks for part (b) of the question, it was usually because they attempted to do it without the calculator or did not know how to enter numbers in standard form into their calculator. These students often failed to take account of the differing powers of ten – this resulted in them adding 9.7 to 2.45 to arrive at 12.15 and then a final answer of this being multiplied by a power of ten, usually 12.15×10^{13}

Question 3

Students gained the mark in part (a) for recognising that the height was incorrect, with some correctly stating that the height should be sqrt7 or 2.6. However, some seemed to think that the front elevation had been drawn as they were under the wrong impression that the arrow always points to the front and so the side elevation would be a triangle, whereas others believed that the elevation should be a trapezium. Some students' explanations were too ambiguous, for example stating 'it should be smaller' with no clear indication as to what 'it' referred to, did not gain the mark. Similar statements mentioning the slant were only given credit if it was clear that the slant was associated with height as otherwise it could have meant that the student thought that the rectangle should have been a parallelogram. Most students drew a rectangle in part (b) although sometimes this was drawn as part of a 3-D shape or as part of a net and in these cases no marks could be awarded. A frequent mistake was to draw one of the dimensions incorrectly, usually the 6 cm, which meant that a maximum of only one mark was awarded. Those students who drew a
correct 7 cm by 6 cm rectangle for the plan often forgot to draw in a solid line in the middle and so only gained the first mark. There were a significant number of students who appeared to be unsure of what was meant by a plan and drew a mixture of elevations labelled as front, top or birds eye view. Without the correct label a mixture of drawings was treated as choice and gained no marks. Students should be advised to draw just the one diagram if they are unsure as a mixture almost never scored a mark even if the correct diagram was seen
(as it often was).

Question 4

A good discriminator with most students showing understanding of working with percentages. There were, though, too many students who just used a simple interest rather than a compound interest process. A common approach was to find 6% of 25000, multiply this by 3 and often add this to the 25000 with 29500 being a very common incorrect answer.

There were multiple errors in copying down the numbers, particularly missed zeros from the 25000 and using a multiplier of 1.006 instead of 1.06. A number of students also mistakenly used a multiplier of 1.03, through either a misunderstanding of the question, or a misread, this could not be credited. Those who gained just 3 of the marks usually did so because they gave the answer as 29775.4. These students were not awarded the accuracy mark as they hadn't taken account of the context of the question, being that we cannot have 0.4 of a person.

Question 5

Most students realised that they needed to find the volume of the flour by dividing the mass by the density. However, many failed to appreciate that the volume of the salt was this volume subtract 700 and so did not gain the second process mark. An unexpectedly high number of students wrote 600/300 but gave the answer as 0.5 or 0.2 instead of 2, hence losing the final accuracy mark. The third process was not for a complete process and a student could gain this mark for 600 / [volume], where [volume] did not have to come from a correct process. Many students gained this mark for a calculation of 600 / 700 or 600 / 1000 but they did not get this mark for 0.857.. seen, this is because the process to arrive at this value had to be shown. Given the more common occurrence of square brackets in the mark scheme it is important that students get into a better habit of showing their method and processes so that they have a greater access to these marks.

Question 6

As would be expected on the higher paper, the completion of the tree diagram was done very well, with a majority of students scoring both marks in part (a). A few students seemed unsure of the probabilities for coin B seemingly thinking it was a conditional probability. In part (b) students scored one of the two marks for writing but calculating incorrectly 0.6×0.55; it was surprising how many students gained only this one mark given that they had access to a calculator. Of those that gained 0 marks for part (b) it was usually because the probabilities were added instead of being multiplied. A significant number of students gained no marks for part (b) as although they calculated 0.6×0.55 they spoilt their method by multiplying or dividing this by 2 or by subtracting it from 1 or adding to another product. All of these resulted in 0 marks being awarded as M1 was for only 0.6×0.55. Students need to be aware that workings seen in part a) ie. 0.33 on the end of the correct path was superseded by new workings in part b) so it is important to show correct processes in the relevant workings area.

Question 7

This multi-step question required the use of a variety of skills being combined to solve a problem and appeared to be challenging to many students. Many students multiplied the radius by the height or finding the surface area or squaring pi instead of the radius or dividing the volume by 3 and, hence spoiling this process. The second process mark was often the only mark being awarded, usually for [volume] ÷ 250. On this occasion [volume] could be anything the student believed to be the volume provided it was not a value that was not allowed as stipulated in the mark scheme. It was unfortunate and relatively rare when students divided something labelled other than volume by 250 and hence not achieving this mark. Again, it is important that students show their method and process so that they have greater access to these marks. A number of students who had a fully correct process to find the time in seconds often stopped short of finding the time in minutes and hence only gained 2 of the 4 marks. With this question, full marks were given for an answer within the range from 62 to 63 inclusive but as the questions stipulated that ‘you must show all your working’ a correct answer with no supportive working scored no marks. It is important that students heed this instruction given on specific questions to ensure that they do not fall foul of this.

Question 8

Many students were able to score at least one mark, and often two, in this question showing some understanding of vector arithmetic. Some students wrote out $2\begin{pmatrix}3\\2\end{pmatrix}+\begin{pmatrix}-1\\4\end{pmatrix}$ but were unable to proceed any further and pick up any marks. Some students tried to square the vector **a** rather than multiply it by 2 giving $\begin{pmatrix}9\\4\end{pmatrix}+\begin{pmatrix}-1\\4\end{pmatrix}$. Students that gained 2 marks often did so for writing the vector $\begin{pmatrix}5\\8\end{pmatrix}$ although there were differing levels of success at drawing it. Unconventional notation was condoned for the method marks with many students missing out the brackets or even writing their answer as a fraction. The coordinate (5, 8) achieved M1 whereas just plotting the point (5, 8) without identification was M0. Most often the last mark was deducted for missing the arrow on the vector. When drawing vectors it is essential to indicate direction. Some students attempted to find the vector 2**a** + **b** by drawing but this method was often less successful. A number of these students had marks deducted as they only drew the vectors 2**a** and **b** without drawing the diagonal line of 2**a** + **b**, ie from start to finish, unfortunately without this diagonal line only one mark was awarded.

Question 9

The vast majority of students gained at least one mark for this question usually for the 6 cubed. The majority of students also gained the second process mark for the process to form an equation or for a process to find h with $0< k \le 1$, it was only the minority who were able to use the correct value of 1/3 for k. Students were, on the whole, very successful at rearranging their formula to find an answer for h. It is important to note that in future series students will be required to have learnt and to be able to apply the formula for the volume of a pyramid in questions such as these. For the accuracy mark students had to have an answer of 10.125 or an equivalent mixed number eg $10\frac{1}{8}$. A final answer of $\frac{81}{8}$ did not gain A1 if the 10.125 or equivalent mixed number were not seen. In questions such as these it is important that students give a suitable answer, ie one which allows an easy appreciation of its magnitude without carrying out a calculation. Similarly, an answer of 10.1 without the 10.125 or equivalent mixed number seen did not gain A1 – students are expected to give the exact answer to a question if it is a terminating decimal.

Question 10

This question was a good discriminator of students understanding of algebraic concepts and proved to be challenging for many. Those that gained all 3 marks for this question usually went down the route of finding the number of yellow counters or the total number of counters in bag **A** in terms of x rather than for starting to work with ratio using algebra eg $3y$, $5y$. Too often students incorrectly had the number of red counters as $3x$ instead of x and hence the number of yellow counters as $5x$ instead of $\frac{5x}{3}$. This incorrect method led to the total number of counters in bag B being $4x$ rather than the total number of counters in bag A and bag B being $4x$ and hence gained no marks. Another common error was for students to think that replacing x with a numerical value was an algebraic approach, as such this gained no marks in the same way that substituting in values for n when trying to prove $n^2 + n$ is always even would gain no marks. There were a few students who lost out on gaining the C mark as rather than using fractions they worked with decimals but did not have these as recurring decimals. The variable 'x' was frequently lost on the total number of counters for bag B meaning marks were deducted.

Question 11

In part (a) most students gained at least one mark for 3 correct values on the box plot. Those who had a good understanding gained three marks. There were a high proportion of students who did not recognise the need to find the UQ and the highest value and only gained one mark whereas some students only found and plotted one of these correctly and hence only gained two of the marks. It was very pleasing to see how the comparison of boxplots in part (b) was answered very well compared to previous series. As previously, examiners expected to see a comparison of the medians and either the ranges or the interquartile ranges with specific reference to the measure used. Students using the wrong vocabulary, using average or mean or medium instead of median and likewise spread or variation instead of range or IQR did not gain marks. Comparisons of the minimum, lower quartile, upper quartile and maximum values also gained no marks. As in previous series there were still some students merely stating values without comparing them. For example, "the median for Friday = 40 whereas the median for Sunday = 42" cannot be given any credit. It should also be noted that there is no need to give values in the comparisons but, if they are given, they must be correct. Students quite often failed to refer to the context of the question eg by referring to speed in some way and so restricted themselves to the award of only one of the two marks available. When trying to compare range and IQR in context a few students who attempted this wrongly interpreted a larger range / IQR to mean that the cars were faster rather than identifying that the speeds were less consistent. A significant number of students used incorrect days in this question; students could be encouraged to underline key information like this so that there is no ambiguity with which box plot they are referring to.

Question 12

Some students were able to pick up one of the two marks for having a triangle of the correct size and orientation but in the wrong position or for 2 out of 3 vertices correctly placed.

However, there were a significant number of students who either misinterpreted the negative for a fractional enlargement or ignored the negative altogether and completed an enlargement of scale factor 2 or –1 or ½ or –½. Others misinterpreted the centre of enlargement and drew their triangle so that it touched the origin and others seemed to draw a triangle that was not similar in a random position on the grid. Many students attempted drawing the projection lines first and trying to fit a triangle within these lines – they knew the orientation and quadrant the triangle should end up in but often did not place the vertices correctly or check that it was the correct size. A few students wrote calculations at the side to work out the directions or new coordinates, this was often successful. Many students used little jumps drawn on the squares to help them count, which was often successful and helped them place the triangle in the correct position.

Question 13

870 was the most commonly seen incorrect answer and was awarded one mark for the correct start of multiplying 30 by 29 to find the number of ways in which two students could be chosen as first and second. Many of these students then failed to recognise that their answer needed to be halved as the order of selecting the two students did not matter. Relatively few students scored full marks. A small number of students successfully used 30C2, which was surprising to see at this level. Commonly seen incorrect answers which could not be credited with any marks included 60 (= 30 × 2) and 900 (= 30 × 30).

Question 14

Another multi-step question that appeared to be very challenging to a large proportion of students, as many struggled with the order in which to carry out their calculations; with many adding both the 1000 and the 750 before dividing by 1.035^2. Those students that carried out their calculations in an incorrect order had access to a maximum of two of the four marks. However, a good start was made by many who usually went down the numerical route of adding 1000 to the final amount of 2937.14, for which the first process mark was gained. The second mark could then be obtained from dividing an allowed value by 1.035.
At this point in their process, there was obvious confusion amongst some students about reverse percentages shown by either multiplying their value by 1.035 or multiplying or dividing by 0.965. Those who were able to achieve these first two marks from a correct process and carrying out the operations in the correct order often successfully completed the calculations and gained all four marks. As with other questions in this paper, the scheme for this question had the use of square brackets and those students that wrote down their process rather than expecting the examiner to guess or assume had significantly greater access to these marks. The numerical approach was more commonly seen and generally more successful than the algebraic approach. It is important that students show clear working and take care to not miscopy numbers on these multi-step questions as very often students work was poorly organised and had evidence of misreading of values.

Question 15

Part (a) was well answered with a high proportion of students gaining the mark. When the mark was not awarded it was usually as the student had expanded the brackets or for incorrectly simplifying the $\frac{a-3}{5}$. In part (b) most students were able to gain at least one of the available marks. Some were awarded one mark for making an error with the signs or for giving two pairs of brackets which when expanded gave two out of three terms correct. Students should be encouraged to multiply out their brackets as a final check - there was little evidence of this taking place. A popular error that resulted in no marks being awarded was to factorise the first two terms and give $k(3k + 11) - 4$ as the answer. Some students went on to equate the expression to zero and solve the equation, which on this occasion was condoned and didn't result in loss of marks. It was surprising how many students used the quadratic formula to find the solutions when the expression was equal to zero, this often resulted in no marks being awarded as the students either thought that this was the requirement of the question or didn't know how to use these solutions to help them factorise. A surprising number gave a solution of 3(k-1/3)(k+4) which also scored 1 mark. Students should be aware that factors within brackets should be integer values. Part (c) was a good discriminator and many students were able to show that to divide the algebraic fractions, they needed to multiply the first fraction by the reciprocal of the second fraction. Fewer students realised the need to factorise the numerator and denominator of the first fraction and many spent time expanding the brackets for no gain and could not then simplify the complex expression generated. Of those that realised the need to factorise many struggled to factorise the $4-x^2$ often factorising this to $(x+2)(x-2)$ instead of $(2+x)(2-x)$ as sign errors were condoned in one bracket, these students were able to gain 2 of the 3 marks. Almost all of those who correctly factorised went on to simplify the fraction correctly and gain full marks.

Question 16

Part (a) was well answered with the majority of students giving the correct answer of –6. In part (b) the most successful approach was to find g(1) and then substitute this answer into f(*x*). However many also found f(1) and then multiplied these two together. As this showed a lack of understanding of composite functions this did not gain the method mark. Less common was to find an expression for fg(*x*) and then to evaluate fg(1). This approach was rarely successful due to students having difficulty dealing with the –3*x*. Part (c) was not well answered with the most common error being to substitute $x = 4$ into $\mathrm{g}(x)$ and some incorrectly interpreted $\mathrm{g}^{-1}(x)$ as the reciprocal of $\mathrm{g}(x)$. It was common for the students who recognised that they could proceed on this question by finding the inverse function but often made a sign error and so arrived at $\frac{x-5}{3}$ or equivalent which prevented them from gaining the method mark. Less students approached the problem by equating the 5 – 3*x* to 4 and solving for *x* but when this method was chosen, it was often done successfully.

Question 17

This question was answered well and it was clear that a good number of students understood the process of iteration. Although a method using powers was rare - most preferring to find the height after each bounce. The students who gained 2 of the 3 marks on this question usually carried out extra iterations as they failed to realise that they only needed to carry out the iteration three times. Some could only show a method for the first bounce and went no further. Less successful responses seemed to be confused by the notation of the subscript and tried to have this as a power or add 1 as a first step or multiplying by 0.55 and then adding 1. Or they demonstrated little understanding of the context (a bouncing ball) by showing values that increased eg by writing $8 = 0.55 \times h_{n+1}$ with the ball getting higher after each bounce.

Question 18

It was encouraging to see that so many students were able to gain the first mark for the correct application of 0.5absinC, and many could take their value for AC and gain further marks for a correct application and rearrangement of the sine rule. Errors in the first step to find the length of AC included treating the triangle ACB as right angled or as an isosceles triangle, with angle ABC assumed to be 35°. Those who were unable to make a correct start on this question could pick up marks later for correct use of the sine rule and the formula for the area of a triangle due to the use of square brackets being used throughout the scheme. Access to these later marks after an incorrect start was dependent on clear working being shown and sides being clearly identified by labelling or on the diagram with no contradiction. As with previous questions it is important that students show their full working to have an increased access to these marks. Of those who gained just four of the five marks, this was usually due to premature rounding and hence having a final answer out of range. It is important that students working at this level do not round their values throughout their processes and only round their final answer.

Question 19

This question discriminated well with the full array of marks being awarded. The lower attaining students restricted their answer to calculating R by substituting in P as 5.88×10^8 and Q as 3.6×10^5, with some then writing the lower bound of this value, but these responses were not awarded any marks. Most students recognised the need to state bounds for P and/or Q and hence gained the first mark for the digits 5875 or 5885 or 355 or 365. This was to allow a mark to be awarded to the students who ignored the $\times10^8$ and $\times10^5$ from P and Q respectively. Many students did not progress beyond the first mark as they attempted to calculate the lower bound of R by dividing the lower bound of P by the lower bound of Q. Of those who gained 2 of the 3 marks it was usually for having the incorrect upper bound for Q, usually as 3.64×10^5 or 3.649×10^5 with no recurring notation. There were some students who were only awarded 2 of the 3 marks as they gave a final answer in standard form instead of an ordinary number. The final mark was only awarded for a final answer in standard form if an answer within the accepted range was given as an ordinary number first.

Question 20

There were a fair number of incorrect responses to both parts of this question with students not understanding what an arithmetic or a geometric sequence was. Many students added or multiplied the first and second terms and equated this to the third term or they added or multiplied all three terms together and equated this to zero. It was evident that those who added the first two terms and equated this to the third were confusing the sequences with a Fibonacci sequence.

In part (a) the most successful students worked out the differences of the adjacent terms and equated these. There were too many students who missed off brackets and this often resulted in no marks being awarded; it is important that students take care with algebraic notation and ensure that brackets are used when necessary. Although the vast majority of students who successfully equated the common differences then went on to achieve full marks there were a few basic algebraic manipulation errors seen with the solving.

Part (b) was designed to challenge the more able students and provide them with the opportunity to demonstrate an understanding of the structure of a geometric sequence. Unfortunately, some treated the sequence as quadratic and despite being tested in part (a) attempts at arithmetic sequence approaches were not uncommon. Some students proceeded straight to $\frac{y+2}{y-4}=\frac{3y+1}{y+2}$ and usually went on to gain at least the first three marks. A number of students made simple errors when expanding brackets and sign errors when collecting terms, from this point no further marks could be awarded. Some students used a different approach and rearranged their equations to make *y* the subject and in terms of *r* but this route was often unsuccessful due to frequent errors.

Question 21

A challenging question, as intended, at the end of the paper. When students were awarded one mark, it was usually for identifying that a side of the smaller hexagon was equal to the radius of the circle or for Perimeter of *PQRSTU* = 6*r*. Some students arrived at this result by using trigonometry whereas others used their knowledge of equilateral triangles. Students found the work required to gain the second mark much more challenging, with most trying to go down the route of finding the length of half of a side of the larger hexagon with various levels of success. A few students attempted to work the question backwards to appear as though they were finding the correct perimeter for the larger hexagon. 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 but where working was muddled, students often lost their way and had marks deducted they might otherwise have gained. Many students had marked deducted because their diagrams were not properly labelled or it was unclear what length they were trying to find an expression for. There was also a tendency to calculate areas instead of perimeters. The students that were able to gain the first two marks, often went on to gain all the marks; scores of 2 and 3 were few and far between. The main reason for a student to score 3 rather than the 4 marks was because they had made a slip within their working, usually dropping an r or for giving a final answer of $3 : \pi : 2\sqrt{3}$ instead of $3 < \pi < 2\sqrt{3}$. It is worth reminding students that in questions in which the answer is given to them in the form of a 'show that' then examiners are expecting to see sufficient working to prove that the result has been derived accurately (and not just stated after only a line or two of either correct or incorrect working).

Summary

Based on their performance on this paper, students are offered the following advice:

- Write down all steps in your working, ensuring work is structured and easy to follow to have access to as many marks as possible. This can partly be done by annotating given diagrams eg labelling sides and angles.

- Check all your working for any errors and to make sure you have not miscopied numbers or algebraic expressions either given in the question or in a previous line of your working. Along with this check that you have answered the question fully eg giving the answer in the required form.

- Practice factorising quadratics, particularly those where $a \neq 1$ or $b = 0$ and check this by expanding the brackets.

- Take care with algebraic notation and ensure that brackets are used when necessary.

- Learn all the necessary formulae eg the formula for the volume of a pyramid, the Sine Rule and the formula for the area of a triangle.

- Only round your answer at the final stage to avoid losing out on the final accuracy mark.

- Be concise when answering questions that require an explanation and don't add in unnecessary calculations that risk the addition of an incorrect statement and the mark(s) being deducted.

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