Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2022

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

Summer 2022
Publications Code 1MA1_1H_2206_ER

GCSE Mathematics 1MA1
Principal Examiner Feedback – Higher Paper 1

Introduction

This paper had a wide range of questions that gave students of all abilities the opportunity to demonstrate their mathematical knowledge and understanding. Students appeared well prepared for the paper and were able to select appropriate methods to solve problems, particularly those that used familiar situations, and apply techniques to more straightforward questions. Many questions were well attempted, especially those of a type regularly seen on papers in the past.

The earlier questions on the paper were generally answered very well, including Q3 which was the first of the problem solving questions. Students appeared familiar with topics such as inequalities, prime factors and cumulative frequency. There were also many well plotted quadratic graphs. However, some students still have common misconceptions as shown when estimating the mean in Q8 and when confusing area with volume in Q9. Students tended to struggle with the questions that were unfamiliar or more complex such as Q13, Q16 and Q21. Algebraic manipulation was a problem in Q19 and prevented many students from making progress.

Arithmetic errors were often the cause of lost marks when the methods and processes used were correct. Students should be encouraged to check their calculations as a significant number of simple arithmetic errors were made, especially in the easier and more straightforward questions.

It was pleasing that many students presented their answers in a clear and logical way that was easy for examiners to follow. The most successful students structured their work clearly and, in many cases, provided annotations which led to fewer missed steps. For some students, poor handwriting and layout of work remains a big problem. Figures were often written poorly which made it difficult for examiners to tell the difference between 3 and 5, between 4 and 9, between 1 and 7 and even between 0 and 6. Centres should emphasise the need for students to write figures clearly to avoid ambiguity and a possible loss of marks.

There were many cases across many different questions of students miscopying their own figures or misreading the numbers in questions. The latter was particular noticeable in Q15(a) where –10.5**e** was very often written as 10.5**e** and in Q19 where the denominators of the fractions were often written down incorrectly.

REPORT ON INDIVIDUAL QUESTIONS

Question 1

This question was answered very well with most students using an algebraic approach to solve the inequality. It was quite common though to see $7x < 35$ followed by an answer of 5 or $x = 5$ or even $x > 5$ which resulted in the loss of the accuracy mark.

Answers of $x < 35/7$ and $x < 35$ were also seen quite often. Students who attempted to solve the inequality by substituting values of x gained the method mark if they identified 5 as the critical value.

Question 2

The majority of students gained two marks for writing 124 as a product of its prime factors, usually by using a factor tree, and relatively few students failed to gain at least one mark. Some students gained the method mark for drawing a correct factor tree with branches ending at 2, 2 and 31 but then failed to write a correct product. Answers such as 2, 2, 31 or $2^2 + 31$ or 2^2 were quite common. Students who showed a complete method but made only one arithmetic error also gained the method mark. The most common arithmetic error occurred at the start of the process when 124 was sometimes split into 2×64 rather than 2×62. Some students failed to recognise 31 as a prime number and made errors trying to further divide it. When no marks were awarded this was usually because the method was incomplete or because there was more than one arithmetic error. Very few students used the division method to find the product of prime factors.

Question 3

Most students made very good attempts at this multi-step question with many achieving full marks. It was pleasing to see many well presented solutions with working out that was easy to follow. The majority of students started by using the ratio $3:7$ to work out that there were 48 cars and gained the first two marks. Many students completed the process by finding $\frac{1}{8}$ of 48 and 25% of 48 and subtracting the numbers of cars that use electricity and the number of cars that use diesel from 48 to find the number of cars that use petrol. Arithmetic errors were quite common and were often made at the final stage when subtracting 6 and 12 from 48. It was surprising that a significant number of students used a build up method such as 10% = 4.8, 10% = 4.8, 5% = 2.4, etc. to find 25% of 48. Centres should note that incorrect statements such as 25% of 48 = 11 or $\frac{1}{8}$ of 48 = 5 can get no credit unless the method for finding 25% of 48 or $\frac{1}{8}$ of 48 is shown. Some students made the mistake of subtracting the number of cars using electricity from 48 and then finding 25% of 42, not 25% of 48. Instead of finding $\frac{1}{8}$ of 48 and 25% of 48 some students chose to combine $\frac{1}{8}$ and 25%, usually $\frac{3}{8}$ rather than 37.5%, and then worked with $\frac{3}{8}$ or $\frac{5}{8}$. The award of the SCB2 for finding the fraction and percentage correctly but not working with the ratio was relatively common.

Question 4

In part (a) the majority of students knew how to write 1.63×10^{-3} as an ordinary number. Common incorrect answers were 1630, 0.0163 and 0.000163.

Part (b) was also answered very well. Incorrect answers were often of the form 4.38×10^n with an incorrect value of n.

Many students started part (c) by working out $4 \times 6 = 24$ and $10^3 \times 10^{-5} = 10^{-2}$. Some went on to give 24×10^{-2} or 0.24 or 2.4×10^{-3} as the final answer and gained one mark only. A very common error was changing 24×10^{-2} to 2.4×10^{-3} instead of to 2.4×10^{-1}. Another common mistake with the indices was $10^3 \times 10^{-5} = 10^{-15}$. Students who did not deal correctly with

$10^3 \times 10^{-5}$ could still gain one mark for an answer in the form 2.4×10^n with an incorrect value of n. Those who converted 4×10^3 and 6×10^{-5} to ordinary numbers before doing the calculation often got into difficulties with place value and rarely gained any marks.

Question 5

It was pleasing that many students gained full marks for finding the value of x, often making use of the diagram as part of their working. The first step for many was to use $(n - 2) \times 180°$ to find the sum of the interior angles of the hexagon or the pentagon and then divide by the number of sides to find the size of an interior angle. Students who used this approach to find the interior angles often went on to show a complete method. Arithmetic errors, particularly when dividing 540 by 5, were quite common. However, these students were still credited with the methods marks. The division of 540 by 5 sometimes resulted in 18 or 180 yet neither of these values is a sensible size for the interior angle of the pentagon and should have alerted students to a problem. Alternatively, some students started by working out $360 \div 6 = 60$ and $360 \div 5 = 72$. Those who realised that these calculations give the sizes of the exterior angles usually went on to get full marks but a significant number of students used them as interior angles and gained no marks. Contradictions on the diagram were common.

Question 6

This question was well answered by the majority of students. The table in part (a) was often completed correctly. Most errors occurred with the substitution of $x = -1$ into the equation and $y = 3$ and $y = -1$ were common incorrect values of y.

In part (b) the plotting of the points was usually accurate. Most students realised that a curve was needed to join the points and it was pleasing to see freehand curves drawn with an appropriate turning point. Some students, however, drew a graph with a flat bottom which resulted in the loss of a mark. Few graphs consisting solely of line segments were seen. These can get at most one mark. Curves that were sloppy and missed a point also gained at most one mark. Students should be encouraged to make sure that their curve passes through all of the points and doesn't consist of more than one curve between any two points.

Part (c) was answered quite well although some students did not know how to use their graph to find estimates for the solutions of the equation. A common error was giving the solutions as coordinates rather than as values. Some students gave the coordinates of the turning point and others gave the values when $y = 1$. Centres should encourage students to mark the intercepts with the x-axis to show where they are attempting to read off values, few students did this. Some students attempted to answer this part of the question by trying to factorise the quadratic rather than reading from the graph as the question asked. Inevitably their factorising was incorrect and they received no marks.

Question 7

The majority of students gained the first mark for a process to find a volume and many went on to give a correct answer. The final mark was sometimes lost because of arithmetic errors, these occurred most often when dividing 81 by 27 or dividing 128 by 64. Having found the volume of each cube some students gained no more marks because they were unable to use density = mass ÷ volume. It was common to see mass × volume and volume ÷ mass being used. Some students did not realise that it was necessary to find the volume of each cube and scored no marks at all. Often these students simply used the figures in the question, dividing 81 by 3 and dividing 128 by 4 or multiplying 81 by 3 and 128 by 4. There were also some students who calculated the surface area of the cubes and attempted to divide the mass by the surface area and gained no credit. Some students included units in their final answer but they were not penalised.

Question 8

It was surprising to see this familiar type of question answered so poorly with many students not knowing how to work out an estimate for the mean. When students did understand what to do it was most common to see two or three marks awarded. Many who scored the first two marks didn't gain the third mark due to arithmetic errors, typically when finding the sum of the five products. Some students did not use the mid-values of the intervals but were still able to gain two marks for using values from within the intervals and dividing the sum of their products by 30. Having found the sum of their products some students made the common error of dividing the total by 5 and gained one mark only for attempting to find correct products. Students should be encouraged to check the reasonableness of their answers; 114 cm is clearly not a sensible answer when the table shows that no day had more than 50 cm of snow. Many students appeared to not understand estimating the mean at all and made no attempt to find fx. Some simply added the frequencies, or the mid-values, and divided the total by 5. A common error was to multiply all the frequencies by 10 before adding them.

Question 9

This question was well answered with many students gaining at least two of the three marks. It was pleasing that most students worked with area and attempted to find the total surface area of the solid. Many students showed a correct process to find the total surface area of at least five faces for each solid and gained the first two marks. Those who showed a complete process to find the total surface area of the solid often gained full marks but some solutions were spoilt by arithmetic errors. The main stumbling block to a correct final answer was not dealing correctly with the parts of the cube and cuboid that are hidden. Many students worked out the total surface area of the cube and the total surface area of the cuboid and added them together, leading to the common incorrect answer of 310. Some added the total surface area of five faces of the cube to the total surface area of the cuboid and got an answer that was 16 cm^2 too big. Students who made the mistake of including four 5 cm by 6 cm faces or four 7 cm by 5 cm faces in the surface area calculation for the cuboid gained one mark only. Some students did not read the question with enough care and worked with volume instead of with area. This question benefited from a systematic approach and there were some very good solutions from students who clearly identified what they were calculating. However, there were many solutions that had calculations dotted around the page making the working difficult to follow.

Question 10

The cumulative frequency table was usually completed correctly with addition errors relatively infrequent. Those who completed the table correctly generally plotted the points and joined them with a curve or with line segments. A common error was for the points (100, 25) and (250, 85) to be plotted at (100, 30) and (250, 90) respectively because students misread the scale on the vertical axis. Lines of best fit were quite common and there were some students who made no attempt to join the points. Graphs drawn with the points plotted at the midpoints of the intervals were awarded one mark if the points were joined but these were seen less often than in previous series. Some graphs were 'squashed' into the region from $x = 25$ to $x = 150$ because students plotted at the midpoints of the intervals in the cumulative frequency table and these graphs gained no marks. Histograms were often drawn and gained no marks unless 5 or 6 of the points were identified and plotted correctly. In part (c) many students gained the mark for reading a value from the graph at Profit = 125. Part (d) was answered quite well with many students able to find an estimate for the interquartile range. Some marks were lost through reading incorrect values from the graph or from not interpreting the scale correctly. Centres should encourage students to show a clear method on the graph as, without this, answers just outside the required range cannot be awarded any marks. Instead of reading across from cf = 25 and cf = 75 some students read from cf = 30 and cf = 70 and some found 25% of 300 = 75 and 75% of 300 = 225 and read up from these values on the profit axis.

Question 11

In order to make progress students needed to link the probability of taking a lime flavoured sweet with the ratio $9 : 4 : x$. Those who started by writing $\frac{3}{7} = \frac{9}{21}$ or formed an equation such as $\frac{9}{13 + x} = \frac{3}{7}$ were usually able to show a complete process to work out the value of x. Some marks were lost through careless arithmetic errors and those using an algebraic approach sometimes made mistakes when solving their equation, such as expanding $3(13 + x)$ incorrectly or incorrectly simplifying $13 + x$ to $13x$. Of the students not scoring full marks few made the connection between $\frac{3}{7}$ and $\frac{9}{21}$.

Question 12

This is a familiar type of question and most students were able to gain the first mark for showing an understanding of the recurring decimal notation. It was pleasing that many students were able to show a complete method leading to a correct fraction. Any subsequent incorrect cancelling of $\frac{116}{990}$ was ignored. Some students got as far as $\frac{11.6}{99}$ but were then unable to complete the method to arrive at a correct fraction. After finding two appropriate decimals to subtract some students spoilt their solution by making careless arithmetic errors such as $1000x - 10x = 900x$. Some students could recall the need to multiply the recurring decimal by powers of ten but were either unable to find the multiples needed to eliminate the recurring nature of the decimal or could not carry out the multiplications correctly. It was common, for example, to see $10x = 1.\dot{1}\dot{7}$ followed by $100x = 11.1717..$ or by $100x = 117.\dot{1}\dot{7}$. Some students did not understand the recurring notation, writing 0.117117... or 0.171717...

Question 13

This was an unfamiliar type of question but even so it was not answered as well as might have been expected. Many students recognised that the question required the use of Pythagoras and wrote down Pythagoras' theorem, often as it appears on the formula sheet. This alone was not sufficient for the first mark – the statement of Pythagoras needed to be linked in some way to the question. Many students did this by labelling the sides of the triangle in the diagram and using these letters in Pythagoras' theorem, some students explained what the letters they used represented. Some students labelled the sides as a^2, b^2 and c^2 and used these incorrectly or used the labels from the diagram to form their Pythagoras equation which was not worthy of any marks unless A, B and C were either clearly linked to the diagram or clearly defined as being the diameters of the semi-circles. It was very disappointing that relatively few students scored the second mark for writing correct expressions for the areas of at least two of the three semicircles. It was very common to see the diameters being used instead of the radii in πr^2 and for expressions to be given for the areas of circles instead of semicircles. Students who labelled the sides $2a$, $2b$ and $2c$ found it easier to write correct expressions for the areas but harder to write a Pythagoras statement. Those who did write correct expressions for the areas were then often not able to complete the chain of reasoning to give a fully correct answer. Students should be encouraged to use brackets correctly. The omission of brackets was rarely recovered and resulted in a loss of marks. Students who used numerical values for the sides of the triangle were still able to access the first two marks but a surprising number of these students were unable to write correct expressions for the areas and gained the first mark only.

Question 14

Where tangents were drawn they were generally accurate and students often went on to gain all three marks for working out an estimate of the gradient that was within the acceptable range. Some answers were given in the form a/b and the final mark was lost when a and b were not integers. Errors were often the result of reading the scales incorrectly although some students divided the change in x by the change in y. A significant number of students drew a tangent, thus gaining the first method mark, but could not then complete the method to find the gradient. Many students used the coordinates of the point on the curve at $t = 2$ and simply divided 2.8 by 2. Some of these students had already drawn a tangent to the curve at $t = 2$.

In part (b) many students knew that the area under the graph represents the distance travelled. Incorrect answers often referred to acceleration or to time. Some students gave the answer as velocity or speed.

Question 15

In part (a) the first mark was awarded for indicating that $15\mathbf{a} + 20\mathbf{b}$ is 5 times $3\mathbf{a} + 4\mathbf{b}$ and a good proportion of students managed to do this. Some students wrote "×5" between the two vectors but did not write a mathematical statement linking $\overrightarrow{AB}$ and $\overrightarrow{AC}$. For the award of both marks it was necessary to see a statement such as $\overrightarrow{AC} = 5 \times \overrightarrow{AB}$ or $15\mathbf{a} + 20\mathbf{b} = 5(3\mathbf{a} + 4\mathbf{b})$ and a correct reason. Many reasons mentioned multiples and some students also referred to the vectors being parallel or having a point in common. Some very good reasoning was seen but on the other hand a large number of students had difficulty formulating a correct reason or gave no reason at all. Some students worked with $\overrightarrow{BC}$ and $\overrightarrow{AB}$ and showed that $\overrightarrow{BC} = 4 \times \overrightarrow{AB}$ or $12\mathbf{a} + 16\mathbf{b} = 4(3\mathbf{a} + 4\mathbf{b})$. A significant number of students, however, thought that simply working out $\overrightarrow{BC}$ as $12\mathbf{a} + 16\mathbf{b}$ was sufficient to show that A, B and C lie on a straight line. Incorrect working such as $15\mathbf{a} \div 3\mathbf{a} = 5\mathbf{a}$ or $(15\mathbf{a} + 20\mathbf{b}) \div (3\mathbf{a} + 4\mathbf{b}) = 5\mathbf{a} + 5\mathbf{b}$ was very common.

In part (b) many students realised that they needed to find the vector $\overrightarrow{DF}$ and gained the first mark for 3**e** + 6**f** + –10.5**e** – 21**f**. Arithmetic errors during this first step were common. Many students then gave –7.5**e** –15**f** : 3**e** + 6**f** as the final answer and gained one mark only. Those students who knew that they needed to do more in order to find a ratio of lengths generally gained the second mark for a multiplicative relationship such as $\overrightarrow{DF} = -2.5\overrightarrow{DE}$ or, more commonly, for writing a ratio such as –7.5 : 3 or –2.5 : 1. In many cases the accuracy mark was lost because the final ratio contained a negative sign. Students could also work with $\overrightarrow{DE}$ and $\overrightarrow{EF}$ but students who took this approach were usually unsuccessful in gaining full marks.

Question 16

Overall, this question was answered very poorly with a large number of students unable to find an appropriate strategy to work out the probability of passing the practical test. Probability tree diagrams were very common but these were of little use to many students as the probability of passing only one of the two parts, 0.36, was often placed incorrectly on branches of the tree diagrams. Some students wrote down a relevant product, often this was $0.75 \times x$, and gained the first mark but many were not able to go on and make any further progress. Statements such as $0.75 \times x = 0.36$ were common because many students did not recognise that there are two ways of passing only one of the two parts. Some of the students who did consider the two ways wrote $0.75 \times x + 0.25 \times x = 0.36$ and gained no more marks. It was also common to see $0.75 \times x + 0.25 \times y = 0.36$ which gained the second mark but this did not necessarily get translated into an equation in one variable and so no further progress was made. Many of those that did show a correct equation such as $0.75(1 - x) + 0.25x = 0.36$ were able to complete the process and give a correct final answer. A small number of students who got as far as forming and solving a correct equation in one variable were confused about what their variable represented and lost the accuracy mark.

Question 17

Many students were able to set up an equation with a constant term and they often wrote down both $y = k\sqrt{t}$ and $t = k/x^3$. Most then went on to gain the second mark for substituting values in at least one equation. The values found for the constants were usually correct although $8 = k/8$ did sometimes lead to $k = 1$. Having found the values of the constants many students did not use them to write down the two equations $y = 5\sqrt{t}$ and $t = \frac{64}{x^3}$. Centres should encourage students to clearly show the equations as doing so would have gained the third mark and it might also have helped them to find a formula for y in terms of x. Many simply stopped after finding the values of the constants and went no further. Those who did continue and gave $y = 5\sqrt{\frac{64}{x^3}}$ as the final answer were not awarded the accuracy mark because the question required the answer to be given in its simplest form. Simplifying $\sqrt{\frac{64}{x^3}}$ to $\frac{8}{x^2}$ was quite a common mistake. Students should ensure that they read the question carefully as a significant proportion failed to recognise “root”, “inversely” and “cube”. Notation when attempting to find the constants was often poor and some students omitted the constant from their initial equation.

Question 18

This was one of the better answered questions towards the end of the paper. Many students gained at least one mark and a good proportion of students gave a fully correct solution. When just one mark was awarded this was usually the first mark for making some progress with the numerator or the third mark for showing that $\div 2^{-3}$ is the same as $\times 8$. After writing $\left(5\frac{4}{9}\right)^{-\frac{1}{2}}$ as $\left(\frac{49}{9}\right)^{-\frac{1}{2}}$ some students were unable to deal with the negative power and a common error was to ignore the minus sign and write $\frac{7}{3}$ or treat the minus sign as a multiplier and write $-\frac{7}{3}$. A number who were able to find $\frac{3}{7}$ made errors converting $4\frac{2}{3}$ to $\frac{14}{3}$. Those who simplified the numerator to $\frac{3}{7}\times\frac{14}{3}$ scored the first two marks. It was surprising to see some students then work with $\frac{42}{21}$ rather than simplifying it to 2. An error here was $\frac{42}{21}=\frac{1}{2}$. Mistakes at the final stage when working with the denominator prevented some students from achieving the accuracy mark. Some used $2^1 \div 2^{-3}$ but combined the indices incorrectly or gave 2^4 as the final answer. A common error was to write the denominator 2^{-3} as –8. Students seemed to struggle with negative indices generally.

Question 19

Relatively few students could demonstrate the necessary skills of algebraic manipulation to solve the equation and give the answer in the required form. Many students were able to correctly write the two fractions with a common denominator and gain the first mark but a significant number were then unable to carry the algebraic solution any further. Those that did reduce the equation to a 3 term quadratic often made errors when rearranging and did not get the second mark. Substitution into the quadratic equation formula was generally done well but some students attempted to use completing the square and this was done less well due to not dealing with the coefficient of 2 correctly. Some students who did not get a correct quadratic equation were still able to gain the third mark for dealing correctly with their 3 term quadratic equation. The final step to write $\frac{10\pm\sqrt{60}}{4}$ in the required form proved difficult with $\frac{5\pm\sqrt{30}}{2}$ a common incorrect answer.

Question 20

It was pleasing to see many students attempting to draw diagrams to help them structure their response. Those who did often then started by finding the gradient of the line from the centre of the circle to the point *A* and gained the first mark. A good number were then able to find the gradient of the tangent and use $y = mx + c$ to find an equation of the tangent. Those who got this far and gained the first three marks often failed to gain the accuracy mark. Sometimes this was due to an error when finding the value of c but more commonly it was because the final equation was not given in the form $ax + by + c = 0$ that was required by the question. A common error at the first stage was for students to attempt to work out a gradient without using both (–1, 3) and (6, 8) and give gradients such $\frac{8}{6}$ or $\frac{1}{3}$. These students gained no marks as did students who changed the circle centre to the origin. A minority of students found an incorrect gradient from using change in x divided by change in y but they could still get two marks if their final equation was $5x + 7y – 86 = 0$.

Question 21

This proved to be a challenging question with very few students showing any understanding of what was required to find the total area of the two shaded regions. Most students failed to find a successful strategy and working out was often messy and difficult for examiners to follow. Fully correct answers were seen only rarely but nevertheless it was pleasing to see some excellent solutions from the most able students taking this paper. The students who scored marks had generally drawn appropriate triangles on the diagram to help formulate their approach. Those who used $\frac{1}{2}ab\sin C$ to find the area of a triangle were usually able to recall the exact value of $\sin 60^{\circ}$ or $\sin 120^{\circ}$. Some students made a good start and gained the first two marks by finding either the area of a triangle or the area of a sector but often they did not find both and were unable to make any further progress. It was pleasing to see many students attempting this question but often they simply found the area of one circle as 16π or the area of three circles and then made incorrect assumptions about the proportion shaded in searching for a solution.

Summary

Based on their performance on this paper, students should:

- take care when carrying out arithmetic operations and check their working to avoid careless errors
- consider whether or not an answer is reasonable and of a sensible size
- read each question carefully and ensure that their final answer matches the question asked
- show their methods clearly when using graphs
- ensure that they know the difference between surface area and volume
- practise working out an estimate for the mean from a grouped frequency table
- practise answering probability questions that require the use of algebra and ratio

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