Examiners' Report
Principal Examiner Feedback

Summer 2023

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

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

Introduction

This paper proved accessible to students with many excellent responses seen to the most challenging questions on the paper. It was pleasing to see that most students attempted most of the questions with few left completely blank.

Students were well-prepared for topics such as subtraction of fractions (Q2), scatter graphs (Q6), direct proportion (Q13) and the product rule for counting (Q19). Students often struggled with a correct method to divide by decimals and with division in general. A large number of students had difficulty interpreting the set notation in Q5b and working consistently in terms of π in Q16. Poor algebraic manipulation in Q15, Q16 and Q17 let students down when rearranging formulae and equations. Simplification of surds was an issue for many students in Q16 and Q23.

It was pleasing that many students presented their working clearly and logically. However, answers to some questions, particularly the ratio problem (Q18), changing the subject of a formula (Q17) and finding an inverse function (Q20a) were not as well presented. Attempts were often quite messy with incomplete methods shown which made them difficult for examiners to follow. Centres should advise students to cross out unnecessary working to avoid leaving a choice of methods.

Carelessness in their working proved costly to some students. This carelessness included errors in simple calculations and imprecise notation when working with algebra, for example brackets missing in Q17 and Q23. Being a non-calculator paper there were frequent instances of arithmetic errors, for example $90 \div 30 = 30$ and $\sqrt{25} = 12.5$, which led to a loss of marks. Often, students did not consider whether or not their answer was reasonable – had they done so, they could have spotted and corrected errors. Once again, there were many cases across many different questions of students miscopying their own figures or misreading the numbers in questions.

REPORT ON INDIVIDUAL QUESTIONS

Question 1

Most students used a formal method to divide a number with the digits 846 by a number with the digits 15 and usually gained the first mark for making a correct start to the method and getting 5 as the first digit. Many went on to gain all three marks. Some of those who divided correctly to get the digits 564 then positioned the decimal point incorrectly and gained only two of the three marks. Having divided 846 ÷ 15 and obtained 56.4 many students then gave the final answer as 0.564 or 0.00564, most likely thinking that they needed to divide 56.4 by 100 or by 10000 because they had multiplied both figures by 100 before dividing. If they had considered the relative sizes of the two numbers in the question then they might have realised that their final answer was not sensible. Arithmetic errors were common but students who had gained the first mark were still able to gain two of the three marks if the decimal place was correctly positioned in their final answer. A number of students did not know how to deal with the final remainder of 6 which often resulted in answers of 56.6. Some students chose to use a build-up method or repeated subtraction to carry out the division but these methods were rarely successful.

Question 2

This question was answered very well. The most common method was to convert both mixed numbers into improper fractions and then write the fractions over a common denominator. Many students gained at least two of the three marks for getting this far. The accuracy mark was often lost because students failed to write their answer as a mixed number or they made an arithmetic error. Many of the arithmetic errors occurred when converting the mixed numbers to improper fractions. Some students used 16 rather than 8 as the common denominator which increased the chances of them making an arithmetic error. Having written both mixed numbers as improper fractions some students made no further correct progress and gained one mark only. Far fewer students chose to subtract the whole numbers and deal with the fractional parts separately. The difficulty that some had with this method was subtracting a larger fraction from a smaller fraction which meant that $7\frac{3}{8}-2\frac{4}{8}$ was often not evaluated correctly.

Question 3

Many students gained the first mark for dividing 150 by 6 to find the area of one face of the cube and very often they went on to score full marks for working out the volume of the cube. After finding the area of one face some students could make no further correct progress. It was common to see 25 divided by 2 or by 4 in an attempt to find the side length and some thought that the volume was given by 25 × 25 × 25. A significant number of students could not show a correct first step and gained no marks. Some attempted to draw the cube and gave a first step of 150 ÷ 3 (presumably the 3 visible faces). Some misinterpreted the question and assumed that 150 was the surface area of one face and wrote $\sqrt{150}$ or divided 150 by 4.

Question 4

Points were generally carefully plotted at the correct heights and many fully correct frequency polygons were seen although the number of students scoring full marks was not as high as might have been expected. Most students joined their points with line segments although some joined them with a curve and some did not join them at all. A very common error was plotting points at the ends of the intervals rather than at the midpoints and some students plotted at the beginnings of the intervals. Some otherwise correct frequency polygons were spoilt by students joining the first point to the last point to form a closed polygon. A number of students drew histograms, which scored no marks unless the correct points were marked at the centre top of each bar which gained one mark or the correct frequency polygon was drawn which gained both marks.

Question 5

A good proportion of students scored full marks in part (a) for correctly placing the ten numbers in the Venn diagram. The most common error was not recognising that 1 is a square number and writing 1 in the region $A \cap B'$ rather than in the region $A \cap B$. Students who wrote the correct numbers in two or three of the four regions gained 2 marks. It should be emphasised to students that each number in the universal set should appear just once in a Venn diagram and it might be advisable for students to cross off numbers as they are being added to the Venn diagram.

In part (b) many students scored one mark for the correct denominator of 10 or for a denominator that followed through from their Venn diagram. A correct numerator was seen less frequently. It was evident that many students were unable to identify the region B' and the most common mistake was to give the probability that the number is in set B.

Question 6

In part (a) the majority of students were able to describe the relationship between the age and the weight of the babies. An answer of 'positive correlation' was acceptable but students who gave an answer of 'positive' or 'positive relationship' were not awarded the mark. The most common error was to state that the weight is directly proportional to the age.

Part (b) was also answered very well. A large proportion of students gained both marks for an answer in the range 2.5 to 4.5 with many drawing a line of best fit. Lines of best fit, if drawn, were normally drawn well. Some students used their line of best fit incorrectly, reading from age = 5.8 rather than from weight = 5.8, and some misread the scale on the age axis. These students still gained 1 mark for drawing a line of best fit. Some lines of best fit were drawn that started at (0, 0) and these gained no mark. A significant number of responses did not use a line of best fit to find an estimate and these were variable in their success. Some students with no line of best fit drew a horizontal line from 5.8 and often these lines did not end within the required range of values and scored no marks.

Question 7

Many students were able to work out the price of the holiday before the increase. Common approaches included 240 × 5 and 10% = 120 so 100% = 1200. Some students showed a method leading to 1200 but then gave a final answer of 960 or, less frequently, 1440. These students gained one mark only. A greater number of students than expected gained no marks at all. Often this was because they misinterpreted the question and took £240 to be the price of the holiday after the 20% increase giving the answer of £200.

Question 8

A good proportion of the students who gained the first mark for dividing 1200 by 40 then went on to show a complete process. Many gained all three marks but some students made arithmetic errors and lost the accuracy mark. Errors such as 1200 ÷ 40 = 300 and 90 ÷ 30 = 30 were quite common. After dividing 1200 by 40 some students did not realise that they had found the value they needed to use in the pressure formula and it was common to see equated πr^2 equated to 30 in an attempt to find the value of r. Some carried out further incorrect work in an attempt to find the 'area' and some made no further progress. A common error was attempting to find the surface area of the cylinder and using this in the pressure formula. Some attempts failed at the first hurdle when students did not know how to use the volume of 1200 cm^3 and the height of 40 cm.

Question 9

Students who realised that the solutions of the simultaneous equations could be found from the point of intersection of the two straight lines usually gave the correct answer. Errors were sometimes made in reading the y value from the graph and some students omitted the minus sign from the y value. Occasionally the x and y values were reversed. Incorrect answers often came from using the points of intersection of the lines with the x-axis and y-axis instead of the point of intersection of the two straight lines. Many attempts at solving the equations algebraically were seen even though the question instructed students to use the graphs. These attempts were usually unsuccessful.

Question 10

It was pleasing that many students gained full marks for finding the size of angle AED. Those who gained the first mark for using $(n - 2) \times 180$ to find the sum of the interior angles of the pentagon or for stating that the sum of the interior angles is 540 usually went on to make further progress. After subtracting 365 from 540 to find the sum of the two unknown angles some students divided the result by 4 instead of by 5. Some who did divide by 5 then decided that angle $AED = 35$ and lost the final mark. Arithmetic errors, particularly when subtracting 365 from 540 or dividing 175 by 5, were quite common. However, students making these errors could still be credited with the process marks if their intended calculations were shown. Some students relied on memory to give the sum of the interior angles of a pentagon and stated an incorrect figure such as 520, 560, 580 without working and gained no marks. A small number of students used an exterior angle approach and subtracted the three exterior angles from 360 to leave 185 to gain two marks but very few went beyond that.

Question 11

Many students gained the first mark for simplifying either the numerator or the denominator with at least two of three terms correct in a product. At this stage the most common mistakes were $6x^{10}y^6$ or $36x^{25}y^9$ or ax^7y^5 instead of $36x^{10}y^6$ in the numerator and $12x^2y^4$ instead of $12x^3y^4$ in the denominator. A good proportion of students completed the algebra correctly and arrived at an answer of $3x^7y^2$. Some students made one error in the numerator or denominator and gained two marks for an answer of the form ax^by^c with two of a, b and c correct (of these the error was often an incorrect coefficient). A small number of students used a different approach and instead of simplifying the numerator and the denominator they chose to start by simplifying $6x^5y^3 \div 3x^2y^7$ and $6x^5y^3 \div 4xy^{-3}$. A common error was for students to introduce plus signs into the numerator and then attempt to expand the two brackets, leading to more than one product for the numerator.

Question 12

After gaining the first mark for writing at least one correct product many students were able to go on and show a complete method by finding the sum of the three relevant products. Some students chose to subtract the probability of Martha winning both games from 1. The majority of those that showed a full method were able to complete the arithmetic and give a correct final answer. A very common error was failing to include the probability of Martha losing both games and finding the sum of only two products suggesting that the students missed or misunderstood the words 'at least' in the question. Some students did not know what to do with the probabilities, often adding them rather than multiplying.

Question 13

This direct proportion question was answered very well. Many of the students who gained the first mark for $y = kx$ or $24 = 1.5x$ went on to give a fully correct answer. When full marks were not gained this was often because of arithmetic errors when dividing 24 by 1.5 to work out the value of k and $k = 1.6$ was frequently seen. A significant number of students used a non-algebraic approach and although these attempts were often successful this approach tended to be more prone to arithmetic errors which resulted in a loss of accuracy. Many who divided 5 by 1.5 lost the final accuracy mark as they rounded 3.33… to 3.3 or 3 before multiplying by 24. Some students used inverse proportion rather than direct proportion and gained no marks.

Question 14

Part (a) was answered quite well with many students able to write $\frac{1}{16}$ as 4^{-2}. Common incorrect answers included $4^{-4}, 4^{-\frac{1}{2}}$ and 4^2.

In part (b), students who interpreted $8^{\frac{5}{3}}$ as $\left(\sqrt[3]{8}\right)^5$ or $9^{\frac{3}{2}}$ as $\left(\sqrt{9}\right)^3$ gained the first mark and usually went on to gain at least two of the three marks for evaluating 2^5 as 32 or 3^3 as 27. Most went on to evaluate both correctly and gave a final answer of 5. When only one term was evaluated correctly it was more often $9^{\frac{3}{2}}$ as 27. Mistakes were more common in the evaluation of $8^{\frac{5}{3}}$ and $2^5 = 64$ was frequently seen. Some students found $\sqrt[3]{8} = 2$ or $\sqrt{9} = 3$ (or both) but then incorrectly multiplied by 5 and 3 respectively instead of raising to a power. Those students who interpreted $8^{\frac{5}{3}}$ as $\sqrt[3]{8^5}$ or $9^{\frac{3}{2}}$ as $\sqrt{9^3}$ gained the first mark but were rarely able to evaluate either $\sqrt[3]{8^5}$ or $\sqrt{9^3}$ correctly.

Question 15

This question was not answered as well as might have been expected and a surprising number of students failed to gain any marks at all. After gaining the first mark for making the y term the subject of $6y + kx - 12 = 0$ or for finding that the gradient of a line perpendicular to $\mathbf{L_1}$ is $-\frac{1}{2}$ some students made no further progress. Many of those that did get both $y = -\frac{k}{6}x + 2$ and the gradient of $-\frac{1}{2}$ could not make the final step of equating the gradients to find the value of k and it was common to see an answer of $\frac{1}{12}$ from multiplying $-\frac{1}{2}$ by $-\frac{k}{6}$. The double minus of $-\frac{k}{6}$ and $-\frac{1}{2}$ caused lots of issues and a significant number of students gave the final answer as –3 instead of 3. An answer of 3 with no supportive working gained no marks because the question required students to show all their working. Common incorrect methods included trying to solve the equations simultaneously.

Question 16

Most students started with a process to find the surface area of the sphere. Some made no further progress but many continued with $4\pi r^2 = 200\pi$ or $4r^2 = 200$ and went on to find the radius and gained the first three marks. Inconsistent use of π was a problem for some. It was not uncommon to see a surface area of 200π followed by $4\pi r^2 = 200$. After showing a correct process to find the radius a significant number of students then failed to get the accuracy mark for finding the diameter of the sphere in the required form. Many could not write $\sqrt{50}$ as $5\sqrt{2}$ with $\sqrt{50} = 10\sqrt{5}$ a common mistake and the radius was often given as the final answer . Instead of starting with a process to find the surface area of the sphere some students started by forming the equation $\frac{3}{8} \times 4\pi r^2 = 75\pi$.

Question 17

More than half of the students who gained the first mark for multiplying both sides of the formula by $(5x + 3)$ to clear the fraction went on to get full marks. Many students, though, did not know how to deal with the fact that x appeared on both sides of the equation or how to deal with the xy term. Attempts to isolate the terms in x were often not successful with sign errors quite common and only some of those who did isolate the terms in x went on to factorise correctly. It was common to see incorrect steps such as $5xy - 8x = -3y - 28$ followed by $5x - 8x = \frac{-3y - 28}{y}$. Students who made a mistake when expanding $4(2x - 7)$ were still able to gain two of the four marks. Some attempts to clear the fraction failed because students did not include brackets and this resulted in them not multiplying both $5x$ and 3 by y. Instead of clearing the fraction as a first step many students worked with the right-hand side of the formula, incorrectly simplifying $\frac{8x - 28}{5x + 3}$ to get $3x - 25$ or $3x - 31$ for example, and gained no marks.

Question 18

Many students struggled to find a strategy that would enable them to solve this problem and there were many solutions that had calculations dotted around the page making the working very difficult for examiners to follow. Many of the algebraic methods broke down at an early stage. After gaining the first mark for writing an equation such as $7c + 5t = 480$ many students were unable to use the ratio $5:9$ correctly to write down a second equation. Writing $5c = 9t$ instead of $9c = 5t$ was a common mistake and the incorrect equations $5c + 9t = 14$ and $c + t = 14$ were frequently seen. Nevertheless, it was pleasing to see some successful solutions from students using an algebraic method. The majority of the correct answers came from students adopting a numerical approach. The most efficient of these saw students working with the ratio of total costs, finding $7 \times 5 = 35$ and $5 \times 9 = 45$, often as $35:45$, and then dividing 480 by 80 to get 6. Multiplying 5 by 6 and 9 by 6 completed the solution. Some students worked out the total cost of the tomatoes and the total cost of the carrots and gained the first two marks but did not find the cost of 1 kg of each. Many of the incorrect strategies were based on dividing 480 by 12 or by 14.

Question 19

This question was answered very well with many students getting both marks for working out the value of x as 7. Some who gained the first mark for a statement such as $5 \times 12 \times x = 420$ were unable to complete the arithmetic correctly. A common error was $420 \div 60 = 70$. Misreads of the number 420 in the question were quite common. Students who misread 420 were still able to gain the process mark but not the accuracy mark. It was quite common to see 5 + 12 used within solutions and incorrect answers often involved an attempt at $5 + 12 + x = 420$.

Question 20

In part (a) the students who knew about inverse functions usually tried to find $g^{-1}(x)$ by rearranging $y = \frac{\sqrt{x}+2}{5}$ to make x the subject or rearranging $x = \frac{\sqrt{y}+2}{5}$ to make y the subject. Many got as far as $5y = \sqrt{x}+2$ or $5x = \sqrt{y}+2$ and gained the first mark. A good proportion of the students who made a correct first step went on to give a correct answer. Those who completed the rearrangement correctly sometimes gave the answer in terms of y and lost the accuracy mark. Some unwisely attempted to expand $(5x - 2)^2$ and if they did so incorrectly they lost the accuracy mark. A common error in the final step of the rearrangement was to follow $5y - 2 = \sqrt{x}$ with $\sqrt{5y-2} = x$. Some students attempted to find the inverse function by using a flow diagram but this approach appeared to be less successful. Incorrect expressions for $g^{-1}(x)$ such as $5(x^2 - 2)$ or $5x^2 - 2$ were often the result of applying the inverse operations in the wrong order. Unfortunately, many students seemed unaware of the concept of an inverse function and some mistook the notation to mean the reciprocal.

In part (b), many students started by finding an expression for $gf(x)$ and gained the first mark. Instead of equating $gf(x)$ with 3 a common error was to substitute $x = 3$ into $gf(x)$ and students doing this gained no more marks. Those who did equate $gf(x)$ with 3 often went on to solve the equation and score full marks. Some students made mistakes when rearranging the equation and some made arithmetic errors when squaring 13 or when dividing 165 by 3, with 53 (from $165 \div 3$) being a common incorrect answer.

Question 21

This question was answered very poorly and full marks were awarded far less often than might have been expected. Many students struggled to make a correct first step with relatively few scoring the first mark for a method to find angle *BAD* or angle *OAB* or angle *OBD*. Some of those who did find angle *BAD* = 32º were not able to show a complete method, often incorrectly assuming that angle *ADO* = 32º. Some students marked angle *CDO* as 90º on the diagram but could make no meaningful progress. Misconceptions abounded, it was common to see angle *BAD* = 64º and angle *ADO* = 51º because students misidentified when to use the circle theorem that angles in the same segment are equal. Many students assumed that *AD* is perpendicular to *BO* and worked with right angled triangles and some incorrectly assumed that they were dealing with parallel lines and attempted to use alternate angles. After scoring the first M mark students were often able to correctly state one circle theorem relevant to their method and gain the C mark. This was mainly awarded for the theorem that the tangent is perpendicular to the radius. Some, however, gave no reason, others gave descriptions which did not include the required key words.

Question 22

Many students drew the lines *FC* and *AC* on the diagram and identified *ACF* as the angle they were attempting to find. Those who drew only the line *FC* often failed to identify angle *ACF*. After identifying the correct angle some students made no further progress and attempts at using Pythagoras were quite common. About half of those who got the first mark, often for a statement such as $\sin x = \frac{6.8}{13.6}$ or $x = \sin^{-1}\left(\frac{6.8}{13.6}\right)$, were then able to give a correct answer. Some students evaluated 6.8 ÷ 13.6 incorrectly, obtaining 2 for example, but many did not attempt to simplify $\frac{6.8}{13.6}$. Had students recognised that 6.8 is half of 13.6 more might have gained the second mark. Some that did get to $\sin x = \frac{1}{2}$ then gave an answer such as 45 or 60. Students who gained the first mark for a correct sine rule statement were often unable to rearrange this correctly to find the value of *x*. Some students presented the exact trig values in tabular form but were unable to apply them to the question.

Question 23

This question involved writing two fractions with a common denominator, rationalising and simplifying surds. There were many valiant attempts achieving varying degrees of success and not many blank responses. Many students started with a method to write the two fractions with a common denominator and gained the first mark. A common mistake, which prevented the award of the second mark, was incorrectly simplifying $\frac{9}{4\sqrt{3}-3} - \frac{8-2\sqrt{3}}{4\sqrt{3}-3}$ to $\frac{1-2\sqrt{3}}{4\sqrt{3}-3}$. Some students were unable to continue the solution any further and gave their single fraction as the final answer. A good number of students though went on to gain the third mark for a method to rationalise the denominator with some giving a fully correct solution. The alternative approach used by a good proportion of students was to start by rationalising the denominator of each fraction before writing the fractions with a common denominator. The main obstacle to a successful outcome for these students was making errors when manipulating the surds with common mistakes being $\sqrt{3} \times \sqrt{3} = 9$ and $\sqrt{3}(3\sqrt{3}) = 3\sqrt{3} + 3$. Those who used this approach were more likely to give a fully correct answer. Some students used a hybrid approach, rationalising one fraction before trying to achieve a common denominator and then rationalising again. This route had comparable success with the other routes.

Question 24

It was pleasing to see so many students attempting the final question on the paper. Higher attaining students usually made a good start by showing a correct method to find the critical values for at least one of the inequalities and often for both. Many factorised $4x^2 - 25$ and gained the first mark for $(2x + 5)(2x - 5)$. Those who rearranged it to $x^2 < 25/4$ often failed to complete the method by finding both the positive and negative square root. Inevitably, some errors (mostly sign errors) were made in the factorisation of $12 - 5x - 3x^2$ and those who rearranged the inequality to $3x^2 + 5x - 12 < 0$ tended to make fewer mistakes. After finding the critical values many students were not able to use them correctly to solve the inequalities. It was very common to see $x < -2.5$ and $x < 2.5$ for $4x^2 - 25 < 0$ and $x > -3$ and $x > \frac{4}{3}$ for $12 - 5x - 3x^2 > 0$ with students using < or > to match the original inequality. Students were more successful in writing the solution to the first inequality, $-2.5 < x < 2.5$, than the solution to the second inequality. The latter was often given as $x < -3$ and $x > \frac{4}{3}$ rather than as $-3 < x < \frac{4}{3}$. Drawing a sketch of the curve helped some students but there were others who drew a correct sketch and were still unable to identify the relevant region. Furthermore, students who drew sketches often drew $y = 12 - 5x - 3x^2$ as if it were a positive quadratic which led them to deduce an incorrect critical region. Students who solved both inequalities correctly were often able to identify the set of possible values as $-2.5 < x < \frac{4}{3}$ and gain full marks. Some students gave the final answer as –2, –1, 0, 1 or used ≤ instead of < and lost the accuracy mark.

Summary

Based on their performance on this paper, students should:

- practise their arithmetic skills, particularly division and operations with decimals
- take care when carrying out arithmetic operations and use logical checking processes to make sure that their answer is sensible
- become more familiar with the set notation for the complement of a set and how to identify it on a Venn diagram
- know the difference between stating the type of correlation and describing a relationship and should not confuse positive correlation with direct proportion
- practise finding angles using the circle theorems and stating the circle theorems used
- practise algebraic manipulation including rearranging formulae, using index laws and solving equations

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