Examiners' Report
Principal Examiner Feedback

Summer 2018

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 allowed brighter students to shine yet it was accessible to the vast majority. Generally, students seemed well prepared for the paper and responded well to the demands of the new specification. A large number of students were able to engage with every question, even if only to access the first few marks, and continued working to the end of the paper. Even so, there appeared to be some weaker students who might have been better entered for the Foundation Tier.

It was pleasing to note that most students showed their working which enabled examiners to award method marks and process marks, especially where there were inaccuracies in the arithmetic. Some examiners noted an improvement in the setting out of solutions to multi-stage problems although working out was not always as well organised as it should be, most notably in questions 4, 11, 16, 19 and 20. Students should be encouraged to set their working out clearly as unstructured responses which are continued in different sections of the page make the processes being applied difficult for examiners to follow.

Students did not always read the question carefully enough and lost easy marks as a result (e.g. question 1 which required the answer to be given as a mixed number in its simplest form and question 4 which asked students to "estimate"). Greater attention to detail would improve overall marks for some - by providing the correct units for surface area, for example, or by ensuring accuracy when drawing a box plot or sketching a graph.

On this non-calculator paper poor arithmetic often let students down when they knew the correct process. Specifically, knowledge of times tables and ability to multiply and divide effectively were often disappointing and led to a loss of marks. Sometimes students could have chosen a strategy that would have reduced the complexity of the arithmetic required. When trying to evaluate a two stage calculation involving both multiplication and division, for example, students should be reminded to try and simplify the calculation by first dividing to make the final product easier to evaluate. Many students showed perseverance when dealing with difficult calculations, although often these calculations were unnecessary or incorrect due to errors in their processes. It was also noted that students gave answers which could have been identified as incorrect had a quick test of reasonableness been applied.

Examiners commented on an improvement in the application of ratio and proportion and reported that many students demonstrated good problem solving strategies. In terms of algebra it was felt that students are now handling questions involving the equation of a straight line and, in particular, a perpendicular line more competently. However, algebraic manipulation frequently caused problems, particularly the use of brackets when subtracting one expression from another. Incorrect 'simplification' of an answer that was already in its simplest form resulted in a loss of accuracy marks in questions 11, 14, 15(b) and 17.

Report on Individual Questions

Question 1

Part (a) was generally answered well. The most common approach was to convert both mixed numbers into improper fractions and then add these fractions using a common denominator of 28. Errors were made when converting to improper fractions and when writing to a common denominator. Any mistakes made converting $\frac{95}{28}$ into a mixed number were not penalised because writing the answer as a mixed number was not required. Students who chose to add the whole numbers and add the fractions not only had a quicker method but also one that resulted in fewer arithmetic errors. There were of course some students who did not know that a common denominator was needed. A common error was to add the denominators 4 and 7.

In part (b), the requirement for the answer to be given as a mixed number in its simplest form meant that many students gained only one of the two marks. Most students started by converting $1\frac{1}{5}$ into an improper fraction. This was not always done correctly. The standard method $\frac{6}{5} \times \frac{4}{3}$ usually resulted in $\frac{24}{15}$ and final answers of either $1\frac{9}{15}$ or $\frac{8}{5}$ were very common. Some students appeared confused as to which fraction had to be inverted; occasionally both were. Students who chose to start by writing $\frac{24}{20} \div \frac{15}{20}$ gained the first mark but were usually unable to complete the method successfully. Attempts at using decimals were rarely seen and seldom successful.

Question 2

This ratio question was well answered. In order to make progress students needed to associate corresponding parts from the two ratios. Those that wrote down the ratios 14 : 8 and 8 : 5 or the ratio 14 : 8 : 5 were often able to go on and work out the number of houses. A few students obtained the ratio 56 : 32 : 20 and arrived at the answer by using 2.5 × 56. Many students started with a process to find the number of flats, e.g. 50 ÷ 5 × 8 = 80. Sometimes the number of flats was shown in the ratio 80 : 50. A common error was to write the ratio 7 : 4 as 70 : 40 and state that there are 70 houses. Having found that there are 80 flats some students were able to complete the process to find the number of houses, e.g. 80 ÷ 4 × 7 = 140. If the final answer was given as 270 (the total number of houses, flats and bungalows) students were not penalised if 140 was clearly identified as the number of houses in the working. The ratios 7 : 4 and 8 : 5 were sometimes combined incorrectly to give 7 : 12 : 5 or, less frequently, 7 : 32 : 5. Some students started by adding the numbers in the ratios, working out 7 + 4 = 11 and 8 + 5 = 13, but were often unable to make any further meaningful progress.

Question 3

Most students made very good attempts at this question with about two thirds of students achieving full marks. It was pleasing that working out was usually easy to follow. The first two process marks were usually gained by working out the number of bags of sweets that Renee sold (20) and multiplying this number by 65p to find that she got a total of £13 from selling all the bags. A few students were unable to multiply 65 by 20 correctly, usually due to place value errors. Some students decided to work out the cost price of each bag of sweets (50p) or to work out both the cost price (£2) and the selling price (£2.60) of 1 kg of sweets. Relatively few students failed to use 1000 g = 1 kg

Many of those who worked out that Renee made a profit of £3 were able to go on and work out her percentage profit although a number of students did get stuck at this stage. Some students used 3 ÷ 10 × 100 and others argued that since £10 = 100% then £3 = 30%. It was not uncommon, though, to see 3 ÷ 10 × 100 incorrectly evaluated to give an answer of 33.3%. Some students used 13 ÷ 10 × 100 = 130 and those who forgot to subtract 100 and gave a final answer of 130 gained 3 of the 4 marks. Students who did not know how to work out the percentage profit often gave a final answer of 3%. A method for finding the percentage was not always shown. Students who had made an earlier arithmetic error were still able to gain the third mark for using percentages correctly but they needed to show their process in full; those using a build-up method tended not to do this.

Question 4

Marks were often lost in part (a) because students did not read the question carefully or did not understand the implications of the word "estimate". Most students were able to demonstrate a full process to find the number of days which earned them one mark but there was a significant number of students who used very little rounding or indeed no rounding at all. As this question was testing estimation skills students who used no rounding at all gained a maximum of one mark.

The most common approach was to round 3069.25 and 15.12 to 3000 and 15 respectively. Some students then worked out 3000 ÷ 15 and divided the result by 8 whereas others first worked out 15 × 8 and divided 3000 by the result. Either way students had straightforward calculations to carry out which they usually managed successfully. Many different and valid examples of rounding were seen. 3069.25, for example, was rounded to 3000, to 3100, to 3070 and to 3069. Some students chose to round 15.12 to 15, others chose to round it to 20, and 8 was sometimes rounded to 10. Sensible rounding of intermediate values also took place, the most common being 15.12 × 8 = 120.96 which was then rounded to 120 or 121.

A few students rounded 3069.25 to 4000 which is not an appropriate rounded value and these students were not awarded the accuracy mark. Centres and students should be aware that rounding values to 1 significant figure in order to estimate is not always the most appropriate way to solve a problem. Some students lost time trying to find the answer without rounding, before realising they needed to use rounded values and crossed out all their original working. Those who attempted division without rounding often used chunking or build-up methods that took considerable time.

Part (b) was well answered with most students explaining that the time taken would be less as Juan's speed has increased. Some students explained that the answer would not be affected because they would round both 15.12 and 16.27 to 20. Answers such as "Juan will do more miles per day" or "Juan will be quicker" gained no credit because they do not explain how the answer to part (a) is affected. This part of the question was well answered even when students had not achieved a fully correct approach in (a).

Question 5

Most students drew an isosceles triangle in part (a) and often this triangle had base 6 cm and height 4 cm. A frequent mistake was to draw the triangle with an incorrect height, most commonly this was 5 cm, which meant that only one mark was awarded. Some students did not know what was expected for a front elevation. Sometimes the isosceles triangle was drawn as part of a 3-D shape or, less commonly, as part of a net and in these cases no marks could be awarded.

In part (b) many students knew that to find the total surface area they needed to find the areas of the base and the four triangular faces. Many fully correct answers of 96 were seen. A very common mistake was to use 4 cm rather than 5 cm as the height of a triangular face and students who did this were awarded one mark if they completed the rest of the method correctly and gave an answer of 84. Some students used two triangles of height 5 cm and two triangles of height 4 cm. Some forgot to halve the product of base × height; others halved both! Volume calculations using 1/3×base×height were also seen. The final mark was for giving the correct units with the total surface area and this could be awarded whether or not any value given for the total surface area was correct. There were of course those students who gave no units at all and some who wrote cm or cm^3 instead of cm^2.

Question 6

A variety of different methods were used to work out the coordinates of *C*. A common first step was to find the difference between the coordinates of *A* and *B*, 38 − 6 = 32 and 36 − 7 = 29, and this earned the first mark. At this stage some students chose to work with the gradient of the line *AB* but this was not a useful strategy since the line *AB* does not pass through *C*. Many students, however, decided to work out 32 ÷ 4 = 8 to find the side length of a square or 32 ÷ 2 = 16 to find half the width of the diagram.

Students who arrived at 8 or at 16 were in a good position to go on to find the coordinates of *C*, using for example 38 − 16 = 22 and 36 − 16 = 20, but many did not manage to reach (22, 20). When just one of the coordinates was correct it was most often the *x* coordinate. A common mistake was to work out 29 ÷ 4 = 7.25 or 29 ÷ 2 = 14.5 which meant that (16, 14.5) and (22, 21.5) were common incorrect answers. In order to find the *y* coordinate of *C* some students worked out the vertical distance of *C* from the bottom of the second square or from the top of the second square, usually by considering the difference between 36 – 7 = 29 and 3 × 8 = 24, and these attempts often lead to the correct *y* coordinate. Some of those who annotated the diagram seemed to find this beneficial. A very common approach was for students to find the midpoint of *AB*, (6 + 38) ÷ 2 = 22 and (7 + 36) ÷ 2 = 21.5. Although this approach gave the correct *x* coordinate it did not help students to find the correct *y* coordinate.

Question 7

Most students attempted to draw shapes **R** and **S** on the grid and these were often shown in the correct positions. Errors in the positioning of shape **R** and shape **S** were usually due to students not being able to identify the lines $x = -1$ and $y = -2$ although it was not uncommon to see shape **R** one square to the right of its correct position with the line $x = -1$ drawn. In some responses it was difficult to determine how the students had come up with their images. Students who drew shapes **R** and **S** in the correct positions were usually able to recognise that the single transformation that will map shape **T** to shape **S** is a rotation (or an enlargement, which was rarely seen as an answer) although some thought that it is a reflection.

Descriptions of the transformation were generally good although mistakes were sometimes made with the angle or with the centre of rotation and a few students referred to a 'turn' rather than a 'rotation'. It is not acceptable to write the centre of rotation as a vector. It was apparent that some students had used tracing paper when answering this question and this was generally a successful strategy for determining the centre of rotation. Some students gave more than one transformation and got no marks for the description; these seemed to be fewer in number than in previous series. Students who failed to gain any marks for the description of the transformation were still able to get one of the two marks for a fully correct diagram.

Question 8

This question was generally answered very well with most students able to find the lengths of the sides of the triangle by dividing 72 in the ratio 3 : 4 : 5. A common error was to divide 72 by 3 and by 4 and by 5. Few students used the alternative method of scaling up ratios to find the lengths of the sides. Having found the lengths of the sides most students went on to identify the correct two sides for the area calculation and use a correct method to find the area of the triangle. A few students used 18 cm and 30 cm instead of 18 cm and 24 cm and some forgot to divide by 2 when finding the area. The accuracy mark was often lost because of arithmetic errors, particularly in the area calculation. Some students sensibly reduced ½ ×18×24 to 9×24 or to 12×18 but others correctly wrote ½×18×24 but then halved both 18 and 24 before multiplying. The majority chose to multiply 18 by 24 and then divide by 2. Very few students used the method of scaling area.

Question 9

Part (a) was answered well. A common incorrect answer was 18.

Students were even more successful in part (b). Not surprisingly, the two most common incorrect answers were 0 and 23.

In part (c), many students were able to gain at least one of the two marks. Most commonly one mark was awarded for working with a cube root with fewer students showing understanding of working with a reciprocal. A common approach was to deal first with the power of 2/3, for example, $\sqrt[3]{27}$ = 3, 3^2 = 9, but many students then failed to deal with the negative power. The most common error made in this question was $\sqrt[3]{27}$ = 9. Some students got as far as 3^{-2} but then gave the answer as –9 or –6. Students who attempted to square 27 before finding the cube root usually got into difficulties. A common incorrect first step was to write $27^{3/2}$. A number of students merely found 1/3 of 27 or 2/3 of 27 instead of using indices properly.

Question 10

Part (a) was a straightforward question for the vast majority of students who knew how to draw a box plot. Some students lost one mark for an error in plotting one of the five values.

In part (b), fewer students than might have been expected realised that 3/4 of the girls have a height between 133 cm and 157 cm. Those who did were almost always able to work out 3/4 of 80 and score 2 marks. A few students just wrote 75% or 3/4 which did not gain any credit. A surprising number of students did not connect the stated values with their positions within the data set so were unable to recognise that they needed to work with 3/4 of the 80 girls. Common incorrect methods included 157 – 133 = 24, 4/5 × 80 = 64 and 24/37 × 80.

Question 11

Many students started by drawing in the radius *OB* and marking angle *ABO* as *x*° although there was a significant number of students that took angle *ABC* to be *x*°. There was generally a good recognition of the 90° angle between a radius and a tangent with angle *OBC* usually marked as a right angle on the diagram. Some students were unable to make any further progress but those who realised that angle *BAO* = *x* were then in a position to use the sum of the angles in triangle *ACB* to find the size of angle *ACB*. Many students, though, decided to also work out the sizes of angles *AOB* and *BOC*. The latter caused difficulties, with students struggling to simplify 180 – (180 – 2*x*) or writing it incorrectly as 180 – 180 – 2*x* and sometimes giving the unreasonable negative answer of –2*x*. Students who were able to write a correct expression for angle *ACB* in terms of *x* were not always able to write the expression in its simplest from and some who did get to 90 – 2*x* then 'simplified' it to 45 – *x* and lost the accuracy mark. This question required students to give reasons for each stage of their working.

It was encouraging to see responses with full and correctly worded reasons but unfortunately many students did not use the correct terminology. Many of the reasons given for angle *OBC* = 90°, for example, made no mention of 'radius'. Statements such as "the angle between a tangent and a circle is 90º" or "the tangent is at right angles to the circumference" were very common. Students who found the size of angle *ACB* as 90 – 2*x* but gave no correct reasons were awarded 3 of the 5 marks. A small number of students drew the chord from *B* to the point where *OC* cuts the circle and then used other circle theorems, sometimes with complete success. Some students were unable to deal with the '*x*' and worked with numbers and it was not uncommon to see angles *AOB* and *BOC* marked as right angles.

Question 12

For those who realised that an algebraic proof was needed the main obstacle to a successful outcome was writing a general expression for an odd number to start the proof, with $n + 1$ a common incorrect expression. The most common correct expressions used were $2n + 1$ and, to a much lesser extent, $2n - 1$. Some errors were made when expanding $(2n + 1)^2$. A few students expanded it to $4n^2 + 1$ and occasionally the squared term was given as $2n^2$ rather than as $4n^2$. Most of the students who arrived at $4n^2 + 4n + 1$ were able to conclude the proof by factorising it to $4(n^2 + n) + 1$ or $4n(n + 1) + 1$ or by explaining that since both $4n^2$ and $4n$ are multiples of 4 then $4n^2 + 4n + 1$ must be 1 more than a multiple of 4. Some students concluded with a statement such as $4n^2 + 4n + 1 = 4n + 1$ or substituted values into $4n^2 + 4n + 1$ and did not gain the final mark. Students who did not appreciate that an algebraic proof was required in this question simply squared various odd numbers and explained that each result was 1 more than a multiple of 4. Such responses were very common and gained no marks.

Question 13

The most common method was to start by expanding the bracket and many students gained the first mark for $\sqrt{40}+\sqrt{90}$. A very common mistake was to follow this with $\sqrt{130}$ which meant that no further marks were awarded. Another error was to write $\sqrt{40}+\sqrt{90}$ as $4\sqrt{10}+9\sqrt{10}$. Students who got to $\sqrt{4}\times\sqrt{10}+\sqrt{9}\times\sqrt{10}$ usually went on to complete the solution. Some students started by simplifying $\sqrt{8}+\sqrt{18}$ to $2\sqrt{2}+3\sqrt{2}$. It was common to see $\sqrt{8}+\sqrt{18} = \sqrt{26}$. The question asked for the value of *a*. Students who wrote $5\sqrt{10}$ on the answer line rather than just 5 lost the accuracy mark.

Question 14

Many students were able to set up at least one correct proportional relationship and often wrote down both $y \alpha 1/d^2$ and $d \alpha x^2$. At this stage a common error was to use direct proportion instead of inverse proportion and vice versa.

Students who used the constant k and wrote $y = k/d^2$ or $d = kx^2$ were usually able to substitute and find the value of the constant although the rearrangement of the equation to make k the subject sometimes went wrong. Some students did not write down an equation involving k and statements such as $24 \alpha 2^2$ were common. Many of the students who found the values of the constants were not able to use $y = 400/d^2$ and $d = 6x^2$ to find a formula for y in terms of x. Many simply stopped and went no further. Those who did continue sometimes wrote $y = 400/6x^2$ rather than $y = 400/(6x^2)^2$. The question required the answer to be given in its simplest form so students who gave the answer as $y = 400/36x^4$ were not awarded the accuracy mark. Some students could not simplify $y = 400/(6x^2)^2$ which appeared to be due to issues squaring $6x^2$.

Question 15

Students who recognised the expression in part (a) as the difference of two squares almost always gave the correct answer, $(a - b)(a + b)$. A common incorrect answer was $(a - b)^2$.

Students who used the result from part (a) to simplify $(x^2 + 4)^2 - (x^2 - 2)^2$ in part (b) were in a small minority but these students were often successful. Most students started again and expanded both $(x^2 + 4)^2$ and $(x^2 - 2)^2$ with many able to expand one of the two brackets correctly. Mistakes such as $x^2 \times x^2 = x^3$ or $x^2 \times x^2 = 2x^2$ or $(x^2 + 4)^2 = x^4 + 16$ were frequently made in the expansions. A significant number of those who attempted to subtract $x^4 - 4x + 4$ from $x^4 + 8x + 16$ were not able to write a correct expression without brackets. The use of brackets and negative signs was poor.

Students who did progress from $(x^4 + 8x^2 + 16) - (x^4 - 4x^2 + 4)$ to $12x^2 + 12$ sometimes showed the intermediate step of $x^4 + 8x + 16 - x^4 + 4x - 4$. When $x^4 + 8x + 16 - x^4 + 4x - 4$ was shown it was sometimes simplified to $12x^2 - 12$. Many students wrote $x^4 + 8x + 16 - x^4 - 4x + 4$. Although some did recover to get to $12x^2 + 12$ most did not and incorrect answers of $4x^2 + 20$ were common. Having got to $12x^2 + 12$ some students 'simplified' their answer further to $x^2 + 1$ and lost the accuracy mark. This question proved to be a good test of algebraic techniques including the use of brackets, expansion of brackets and working with negative signs.

Question 16

Once students had identified a suitable strategy to use they were often able to work out the probability that Sam takes a red counter, though there were many errors in arithmetic. Successful solutions often started with students working out that the probability of taking a red counter or a blue counter is 0.8 and then finding 3/20 of 0.8. Division of 0.8 by 20 often lead to arithmetic errors. Some students worked out that if 20 red counters and blue counters represent 80% of the total number of counters then the total number of counters must be 25, often using an argument such as "80% = 20, 20% = 5". Those that attempted to divide 20 by 0.8 often got into difficulties. A common error was for students to work out that the total number of counters is 24, e.g. 80% = 20, 20% of 20 = 4, 20 + 4 = 24. Some students assumed that there are 100 counters altogether and were able to work out that there are 12 red counters. Many students failed to find a successful strategy and in these cases the working out was often messy and difficult for examiners to follow. There were quite a few attempts at representing the information in tree diagrams and in ratios. These were generally unhelpful.

Question 17

This was a straightforward question for those students who were well practised in factorising quadratic expressions and there were many students who gained full marks. The denominator was correctly factorised more often than the numerator although some students did try to factorise the denominator into two brackets. Those that factorised correctly generally went on to gain full marks. When the correct answer was followed by incorrect cancelling, to $x + 1$ or to 2 for example, the final accuracy mark was not awarded. A significant proportion of students incorrectly cancelled values and letters without any attempt at factorising. Some students attempted to multiply the numerator and denominator together.

Question 18

Many good attempts at the translation were seen. Some students lost marks because their sketches were hastily drawn and did not pass through the required points. Students would be well advised to look for those points where the graph passes through integer coordinates and transform these points carefully. Some students gained one mark for drawing a correct graph through four of the five key points or for translating the graph in the y direction. Most commonly this translation in the y direction was a translation of +2 or a translation of two 2 mm squares. Some students confused $y = \sin x° - 2$ with $y = 2\sin x°$ and drew the corresponding stretch. Another common error was to reflect the curve in the x-axis.

Question 19

It was pleasing that many fully correct and well presented solutions were seen. Many students recognised that the first step was to rearrange the equation of the straight line to make y the subject. Attempts at rearranging were not always successful. Once y had been made the subject of the equation most students were able to identify the coefficient of x as the gradient. Some students, though, got to $y = \frac{7-3x}{2}$ but made no further progress with the question. There was generally quite a good understanding that the gradient of PQ is obtained by finding the negative reciprocal of the gradient from the rearranged equation. A common error was to write the gradient as $-\frac{3x}{2}$, sometimes followed by the perpendicular gradient being $\frac{2}{3x}$. The most common approach to finding an equation for the line through P and Q was to use $y = mx + c$ or the equivalent form $y - y_1 = m(x - x_1)$. Some of those who used $y = mx + c$ did not substitute $x = 3$ and $y = 4$ to find the value of c; instead they just wrote $y = \frac{2}{3}x + 3.5$. Having got to $y = \frac{2}{3}x + 2$ some students failed to make the final step of substituting $x = a$ and $y = b$. A method used less frequently was to find the gradient of the line through P and Q in terms of a and b and equate this gradient to $\frac{2}{3}$. The main difficulty faced by students using this approach was to rearrange $\frac{b-4}{a-3} = \frac{2}{3}$ to get an expression for b in terms of a. There were many errors in the use of signs.

Question 20

Many students gained one mark for working with the linear inequality. This involved either a method to solve $3n + 2 \leq 14$ or for $3 \times 4 + 2 = 14$. It was disappointing that so many of the attempts to rearrange $\frac{6n}{n^2+5} > 1$ did not lead to $n^2 - 6n + 5 < 0$. It was not uncommon to see $6n > n^2 + 5$ followed by $6 > n + 5$ and $1 > n$. When rearrangement did lead to $n^2 - 6n + 5$ this quadratic was usually factorised correctly but the inequalities that followed were often incorrect. A common mistake was to write $n > 1$ and $n > 5$ or $n < 1$ and $n < 5$.

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 inequalities. Many students used a trial and improvement approach. The mark scheme makes it very clear that trials must be correctly evaluated for marks to be awarded. As with the algebraic method the accuracy mark is dependent on the four method marks having been awarded so students with 2, 3 and 4 on the answer line did not get full marks unless the answer was supported by fully correct working. Students using trial and improvement frequently failed to carry out all the necessary trials and did not therefore receive the full marks possible for this approach.

Summary

Based on their performance on this paper, students should:

- Be reminded to provide the units in a question on area (or volume) when the units are not given on the answer line.
- Practise their arithmetic skills, particularly division and operations with fractions and decimals.
- Practise working out estimates by rounding numbers and develop an understanding of the purpose of rounding so that they can choose appropriate rounded values.
- Practise subtracting one algebraic expression from another, especially expressions with negative terms, and use brackets more efficiently.
- Give correctly worded reasons when presenting a geometric proof.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx