Examiners' Report
Principal Examiner Feedback

Summer 2019

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

Generally students seemed well prepared for this higher tier paper. The paper was accessible to the vast majority of students and it was encouraging that many students attempted all the questions.

The early questions were generally well answered; weaker students struggled with simplifying and multiplying fractions, understanding transformations and in particular translations, and rounding numbers for estimation. Centres should help students to realise that rounding to 1 significant figure is not always the most efficient method of estimating. Providing comparisons in their reasoning in order to gain communication marks needs further development. The more able students were able to work systematically through questions that required multiple steps and were more confident using algebraic approaches, interpreting graphs and working with surds. Students used a range of mathematical methods to tackle questions, showing good understanding of the underlying concepts.

As a non-calculator paper, responses revealed weaknesses in basic arithmetic. 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.

The quality of responses in questions involving ratio is improving and, like many multi-step problems, these are answered well once the student has unlocked the first step of the solution.

It was pleasing that the majority of students showed working out and avoided writing answers on the answer line without some justification. The most successful students structured their work clearly, in the traditional vertical manner, particularly on the earlier questions and in many cases provided annotations which led to fewer missed steps. For others, conversely, poor handwriting and layout of work remains a big problem to the extent that workings are cramped and students even misread their own figures, particularly in the multi-step problems. It was sometimes very difficult for examiners to follow the working shown. It is in a student’s own interest to ensure that working is clearly laid out and flows logically down the page.

There were many instances of marks being lost because students did not read questions with sufficient care. Students should pay particular attention to the final line of a question and follow any instructions given for the type of answer required. On this paper these included “Give the dimensions of the solid on your sketch” in Q4; “Give your answer as a mixed number in its simplest form” in Q9; “Give your answer in its simplest form” in Q14 and the requirement in Q18(b) to give the answer in the form √b/c where b and c are integers. In Q10 many students attempted an algebraic method even though the question instructed them to use the graphs.

Report on Individual Questions

Question 1

Part (a) was answered extremely well. Most of the students who failed to complete the table correctly gave two probabilities that sum to 0.8, e.g. 0.6 and 0.2, and gained one mark.

The most common approach used in part (b) was to find that 0.4 was equivalent to 24 cubes and then work out 12 + 24 + 24. Some students chose to work out 12 × 5 or, less frequently, 12 ÷ 0.2. Marks were sometimes lost through arithmetic errors, on occasion even simple adding up went wrong. Students who had given incorrect answers of 0.6 and 0.2 in part (a) were often able to work out the total number of cubes as 60 in part (b).

Question 2

In part (a) the vast majority of students were able to start the process to calculate the amount of flour by dividing 60 by 4 or by multiplying 50 by 3 and gain the first mark. Most then went on to complete the process to find the amount of flour Deon needs and score full marks.
Those who used a unitary approach, starting with 50 ÷ 15 to find the amount of sugar to make one biscuit, rarely got the correct answer because of arithmetical errors and rounded values but often gained two of the three marks for showing a complete process.

Part (b) was also answered well with most students able to work out that Deon needs 400 g of butter and therefore needs to buy 2 packs. A few students gave the final answer as 1.6 and lost the accuracy mark. Students who made a mistake when calculating the amount of butter could still gain one mark if they divided their amount of butter by 250. A few students did not read the question with sufficient care and divided 600 g (the amount of flour) by 250 and gained no marks.

Question 3

Many students started by drawing factor trees to find the prime factors of 72 and 90 and were then usually able to use the prime factors to find that the highest common factor of 72 and 90 is 18. Sometimes, though, the prime factors were not used in the correct way and the accuracy mark was lost. Effective use was made of Venn diagrams with students generally scoring at least one of the two marks and often both marks. Some students were confused as to which section of the diagram represented the highest common factor. Those students who started by listing factors or factor pairs of 72 and 90 were less likely to score full marks because they often failed to find all the factors or factor pairs. Nevertheless many of these students gained one mark for finding at least 4 factors of 72 and of 90 or for an answer of 6 or 9. Some students found multiples of 72 and 90 rather than factors and gained no marks.

Question 4

Having recognised that the solid shape is a cylinder the challenge for some students was to draw a sketch of a cylinder. Many students did draw an acceptable sketch and those who gave the correct dimensions of the solid on their sketch gained both marks. Some students did not include any dimensions on their sketch or made a mistake with one or both dimensions, giving the height as 4 cm instead of 5 cm for example, and gained one mark only. Labels such as “plan”, “front” and “side” were often seen on the sketches instead of the dimensions. A common mistake was to draw a shape that, at first glance, looked like a cylinder but with an extra face drawn perpendicular to the front face. These types of sketches gained 0 marks.

Question 5

Most of the students who gave the correct values of c and d had first drawn the reflection of shape **A** in the x-axis. Those who did not give two correct values often gained two of the three marks for either $c = -6$ or $d = -1$ or for transposing the two correct values. One correct value, either $c = -6$ or $d = -1$, scored two marks regardless of the second value or the diagram. A surprising number of students with neither value correct spurned the opportunity of scoring a relatively easy mark by failing to draw the reflection of shape **A** in the x-axis, sometimes drawing the reflection in the y-axis or the reflection of shape **B** in the x-axis but often drawing no reflection at all. Some students drew lines between the corresponding vertices of the two triangles, clearly confused with which type of transformation they were dealing with.

Question 6

This ratio question was answered quite well. In order to make progress students needed to associate corresponding parts from the two ratios and work out 2×7, 5×3 and 6×4. Those that found the ratio of the number of pens of each colour sold, 14 : 15 : 24, were often able to complete the process to work out the number of green pens sold.

Most did this by dividing 212 by 53 and then multiplying by 24 but some went from 14 : 15 : 24 to 28 : 30 : 48 and then to 56 : 60 : 96 and usually selected the correct value to give as the final answer. Some students though, found 14 : 15 : 24 but failed to make any further meaningful progress and scored one mark only.

Common incorrect methods used included dividing 212 by 14 (from 7 + 3 + 4) and multiplying the result by 4 or dividing 212 by 4. These approaches made no use of the information about the number of pens in each pack. Students frequently tried different approaches in their attempts at a solution with the result that working out was often very difficult for examiners to follow.

Question 7

It was pleasing that many students gained full marks for finding the length of AB, often making use of the diagram as part of their working. Most students gained at least one mark with relatively few students unable to use the information that the area of $PQRS$ is 45 cm^2 and QR = 10 cm to work out that PQ = 4.5 cm. Having found PQ = 4.5 cm the next step for many students was 26 – 9. Some formed an equation such as $2x + 9 = 26$ but algebraic approaches were quite rare. Whichever approach was used most students were able to show a complete process to find the length of AB although a few got as far as 26 – 9 = 17 and stopped. Arithmetic errors when subtracting 9 from 26 (26 – 9 = 15 was common) or when dividing 17 by 2 meant that the accuracy mark was sometimes lost. A small number of students thought that BC is equal to QR or tried to work with the area of $ABCD$ rather than with the perimeter and gained no marks.

Question 8

Last year's report advised that "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". Those students who rounded 63.5 to 60 and 101.7 to 100 in part (a) usually gained only one of the two marks because they could not deal with $\sqrt{6000}$. Many went on to give an answer in surd form. Students who rounded 63.5 to 64 and 101.7 to 100 were far more successful and 80 was the most common answer. Some students did not understand the implications of the word "estimate" and chose to multiply 64 by 102, gaining no marks.

Part (b) was answered very poorly indeed. Most answers did contain the digits 148 but the decimal point was usually incorrectly placed. The most common incorrect answer was 14.8.

Students were much more successful in part (c). Not surprisingly, the most common incorrect answer was –25.

Question 9

Many students gained at least two of the three marks for converting both mixed numbers into improper fractions (with at least one correct) and then multiplying correctly. The requirement for the answer to be given as a mixed number in its simplest form meant that the final accuracy mark was often not awarded. Answers of $5\frac{6}{10}$ and $\frac{28}{5}$ were common. Some answers were spoilt by arithmetic errors. Having converted both mixed numbers into improper fractions some students chose to use a common denominator of 10. Unfortunately $\frac{35}{10} \times \frac{16}{10}$ was often followed by $\frac{560}{10}$ or by $\frac{51}{10}$ rather than by $\frac{560}{100}$. A few students decided to use decimals and they were often successful. When no marks were scored this was usually because students had chosen to multiply the whole numbers and fractions separately, giving an answer of $3\frac{3}{10}$.

Question 10

Fewer students than expected realised that the estimates of the solutions of the simultaneous equations could be found from 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. Those students that did focus on the point of intersection of the two straight lines did not always score both marks. Errors were frequently made in reading the required values from the graph ($x = 2.5$ was a common error) and some students transposed the x and y values or omitted the minus sign from the y value. Surprisingly few students marked the graph to help them estimate the values. A common mistake was to use the points of intersection of the line $3y + 2x = 1/2$ with the x-axis and y-axis instead of the point of intersection of the two straight lines. Some students gave a correct value for x using the point of intersection but then used the y-intercept as the value for y.

Question 11

Part (a) was attempted well by the majority of students, with many finding all three values accurately. The lower quartile and/or the upper quartile being incorrect was the main cause of lost marks. Students appeared to be more successful in providing accurate values when they made use of the data given in the question, usually by crossing out in a systematic way.

Responses to part (b) were mixed. Students who were not awarded the mark either selected the wrong statistical values to compare, often the greatest and least values but sometimes the values of one or both pairs of quartiles, or stated the median values but failed to provide a comparison between them. Occasionally an incorrect decision, often with a valid comparison was made.

Similarly, responses to part (c) were often incomplete due to students not providing a comparison of the ranges or interquartile ranges of each coach. Some arithmetic errors when calculating the interquartile ranges were also seen at times. Values did not need to be given as part of a reason but any values quoted had to be correct or follow through correctly from the table in part (a). Students should be encouraged to avoid ambiguous statements using words such as "whereas" and “but” when attempting to compare statistical values. A simple comparison that one value is higher or lower than the other is sufficient. The best responses were concise.

Question 12

There was generally a poor understanding of how to tackle this question. A common approach was to assign a value to the volume of P and use it to work out the volumes of Q and R, for example P =100, Q = 150, R = 225. These values were often written on the spheres in the diagram. This was one of the most successful approaches as many students went on to write down an appropriate fraction. Some students made a mistake with the volume of R, writing 100, 150, 200 for example, and gained only the first mark. A different approach was to work out that the multiplier from P to R is 1.5 × 1.5. Whichever method was used the final hurdle for students was to write the volume of P as a fraction of the volume of R. For some this was their downfall. Fractions such as 1/2.25 that contained a decimal were common. These were not awarded the accuracy mark unless they were the result of simplifying a correct fraction. Some students gave an inverted fraction such as 9/4 and there were others who could not complete their method by giving any fraction at all. A common misconception was to assume that the volume of Q is 50% less than the volume of R and the volume of P is 50% less than the volume of Q (writing for example R =100, Q = 50, P = 25 or P = 1/2Q and Q = 1/2R) and give an answer of 1/4.

Question 13

This question was answered surprisingly poorly. Many students did not appreciate what is required in a proof and simply substituted different values of n into $n^2 - n$ and stated that the result was never odd. Such responses were very common and gained no marks. Students who gained one mark for factorising $n^2 - n$ to $n(n - 1)$ were often unable to complete the proof by explaining that $n(n - 1)$ must be even because either n or $n - 1$ must be even. Fully correct proofs were often based on correct reasoning for n even, eg even × even = even and even – even = even with similar reasoning for n odd. A number of students gave reasoning for n odd or for n even but not for both. The use of general expressions for even and odd numbers such as $2n$ and $2n + 1$ was quite common. For many students this was not a wise choice because this approach is unnecessarily time consuming and error prone. For n odd, for example, it is necessary to simplify $(2n + 1)^2 - (2n + 1)$ to $4n^2 + 2n$ and then show that $4n^2 + 2n$ is always even, which is usually done by factorising. Mistakes in simplifying and factorising were common, often arising from a failure to include brackets around $(2n + 1)$. Reasoning for n even often went wrong at the first step with students writing $2n^2 - 2n$ rather than $(2n)^2 - 2n$. Some students completed an argument for n odd but didn’t realise that a similar argument is needed for n even. Attempts at an algebraic proof using n and $(n + 1)$ were quite common and some students simply stated the algebraic statement $n^2 - n$ in words.

Question 14

Students who gave the exact value of either tan30º or sin60º gained the first mark. Various strategies were used to find these values. Some students worked them out by drawing an appropriate triangle; some used patterns in a table with angles of 0º, 30º, 45º, 60º and 90º and some simply recalled them from memory. Sometimes sin30º ÷ cos30º was used to find the value of tan30º. However, the strategies used were not always successful and incorrect values were very common. When only one of the two values was correct it was more often $\sin 60^\circ = \frac{\sqrt{3}}{2}$. In some responses the values were not labelled. If only one value was correct examiners had to assume from the calculation shown that the order was tan30º×sin60º. Some of the students who got to $\frac{1}{\sqrt{3}} \times \frac{\sqrt{3}}{2}$ did not go on to get full marks because they gave $\frac{\sqrt{3}}{2\sqrt{3}}$ as the final answer or simplified it to 2. The question required the answer to be given in its simplest form. Some students used incorrect values such as tan30º = 1 and sin60º = 0.5 which just happened to give an answer of 0.5. When the "correct" answer clearly came from incorrect working a mark of 0 was awarded.

Question 15

Most students were able to gain the first method mark for using a volume formula with the correct substitution. A common mistake at this stage was to use a radius of 6 cm instead of 3 cm. It was also not uncommon to see 3^2 instead of 3^3 substituted into the formula for the volume of a sphere. Having substituted correctly many students failed to gain the second method mark because they found the total volume of a cone and a sphere, not the total volume of a cone and a hemisphere. However, many of these students were still able to gain the third method mark for simplifying the volume of the cone to 30π. Incorrect answers of 66 or 66π, from adding 30π and the volume of the sphere were very common. Many students struggled to simplify their expressions for volume because they had difficulty dealing with the fractions within the calculations. Some left the volume of the cone as $1/3\pi \times 90$ and $4/3\times27$ and $1/2\times4/3\times27$ were often evaluated incorrectly. Generally, answering in terms of π was understood well. Students who used a value for π usually got into difficulties and made little progress.

Question 16

Part (a) was a straightforward question for those who realised that the number of different three digit numbers is given by 5^3 although a surprising number of errors were made in evaluating 5^3. Students often included extra working with 5^3 which invalidated their method, for example $5^3 \times 3$ or $5^3 \times 5$ or $5^3 - 20$, and they gained no marks. A method of $5^3 - 1$ was acceptable because there are 124 three digit numbers that are different to the one in the diagram (553). Common incorrect methods included $5 \times 4 \times 3 \times 2 \times 1$ and $5 \times 3 \times 5$. A few students used listing as part of their method, listing all the three digit numbers starting with 1 for example and then multiplying by 5. Attempts at listing all the possible three digit numbers were hardly ever successful.

Students were less successful in part (b) when finding how many of the possible three digit numbers have three different digits. A common strategy was to subtract the number of three digit numbers that do not have three different digits from the answer to part (a). However, the number subtracted was frequently not 65 and $125 - 5 = 120$ was a common incorrect response. As in part (a) many incorrect methods were seen and attempts at listing were usually not successful.

Question 17

Many of the students who used the given statement, $x^2 : (3x + 5) = 1 : 2$, to form a correct equation were able to give fully correct solutions. Marks were sometimes lost through factorising $2x^2 - 3x - 5 = 0$ incorrectly. Some students gained only the first mark because they could not write their equation (which was often $2x^2 = 3x +5$) in a suitable form ready for solution. Many students scored no marks at although some of these students had attempted to form an equation. Common incorrect equations were $x^2 = 2(3x + 5)$ and $x^2 + 3x + 5 = 3$ and some students used $x^2 = 1$ and $3x + 5 = 2$. Many students, though, simply substituted different values of x into the given statement. This approach sometimes resulted in an answer of $x = -1$ but gained no marks because two values of x are needed.

Question 18

In part (a) many students were able to gain at least one of the two marks for writing $\sqrt{12}$ as $\sqrt{4} \times \sqrt{3}$ or $2\sqrt{3}$. Although most went on to get the correct answer of $3\sqrt{3}$ it was not unusual to see $\sqrt{3} + 2\sqrt{3}$ followed by an answer of $2\sqrt{3}$ or $2\sqrt{6}$. Common mistakes were to write $\sqrt{12}$ as $4\sqrt{3}$ or to write $\sqrt{3} + \sqrt{12}$ as $\sqrt{15}$ and give an answer of $5\sqrt{3}$.

Some students started part (b) by attempting to deal with the power and many were able to obtain $\frac{1}{27\sqrt{3}}$. Different strategies were used to find $\left(\sqrt{3}\right)^7$. Writing out $\sqrt{3}$ seven times and working through the multiplication in a systematic way tended to be a successful approach. The second step for these students was to rationalise the denominator. Instead of multiplying numerator and denominator by $\sqrt{3}$ some students chose to multiply by $27\sqrt{3}$ which resulted in $\frac{27\sqrt{3}}{2187}$. This fraction is not in the required form and the students gained only two of the three marks unless they simplified it to $\frac{\sqrt{3}}{81}$. Students who attempted to deal with the power first but went wrong, obtaining $\frac{7}{7\sqrt{3}}$ for example, sometimes went on to gain a method mark for rationalising the denominator of their fraction. Some students chose to start by rationalising the denominator. Usually this involved multiplying both the numerator and denominator of $\frac{1}{\sqrt{3}}$ by $\sqrt{3}$ to give $\frac{\sqrt{3}}{3}$. Many students could get no further but those who simplified $\left(\frac{\sqrt{3}}{3}\right)^7$ to $\frac{\sqrt{2187}}{2187}$ scored full marks as this fraction is in the required form. Some students started by multiplying the numerator and denominator of $\left(\frac{1}{\sqrt{3}}\right)^7$ by $\left(\sqrt{3}\right)^7$ and frequently got into difficulties. Rationalising the denominator seemed to be much more accessible to students than dealing with the power of 7.

Question 19

A large number of students did not recognise this as a completing the square question or understand how to complete the square. Students who did tackle part (i) by completing the square were generally the most successful and many earned the method mark for getting as far as $(x - 3)^2$. A common mistake made by students who completed the square correctly to get $(x - 3)^2 - 8$ was writing $a = -3$ and $b = -8$ on the answer lines. These students lost the accuracy mark. Those who started by expanding $(x - a)^2 - b$ were less successful. Errors were frequently made in the expansion but many of the students who did get to $x^2 - 6x + 1 = x^2 - 2ax + a^2 - b$ went on to rearrange the equation and did not identify $a = 3$.

Students who had found $(x - 3)^2 - 8$ in part (i) were often able to identify the coordinates of the turning point as $(3, -8)$ in part (ii). It was not unusual to see students who had used an incorrect method in part (i) complete the square in this part to find the coordinates of the turning point.

Any working in part (ii) could not be credited in part (i). An answer of (–3, 8) was a common incorrect answer following a correct answer in part (i).

Question 20

Many students were able to set up at least one correct proportional relationship and often wrote down both $h \propto 1/p$ and $p \propto \sqrt{t}$. At this stage a few students used direct proportion instead of inverse proportion and vice versa. Students who introduced a constant k and wrote $h = k/p$ or $p = k\sqrt{t}$ were usually able to substitute correctly and find the value of the constant. However, a correct substitution did not always lead to a correct value with $6 = k \times \sqrt{144}$ sometimes leading to $k = 2$, for example. Some students found the value of one constant and used it incorrectly in their second equation. Having found $k = 60$ from $10 = k/6$ they then wrote $p = 60 \times \sqrt{144}$ followed by $p = 720$. Another error was to use k as the constant of proportionality in both relationships and to assume that it had the same value in both equations. The use of two different symbols reduced the potential for error. Some students did not write down an equation involving k and statements such as $6 \propto 12$ were quite common. Many of the students who found the values of both constants failed to use them in their original equations and did not write down $h = 60/p$ and $p = 0.5\sqrt{t}$. Those that did gained the third mark and frequently went on to find a formula for h in terms of t. Many students found the values of the two constants but then continued with incorrect further working. Some simply stopped and went no further.

Question 21

Students who knew about inverse functions usually answered part (a) by rearranging $y = 3x - 1$ to make x the subject or rearranging $x = 3y - 1$ to make y the subject. Some mistakes were made in the first step with $y = 3x - 1$ being followed by $y - 1 = 3x$ for example. Most 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 students found the inverse function by using a flow diagram but this approach appeared to be less successful. A common incorrect answer was $1/(3x - 1)$ because some students interpreted $f^{-1}(x)$ as $1/f(x)$, confusing the notation for inverse functions with the notation for a negative power.

Part (b) was very well answered considering that it is one of the more challenging questions on the paper. It was pleasing that many of the students who demonstrated knowledge of composite functions were able to give fully correct answers. Working was generally set out well when students understood what to do. A few otherwise correct solutions were spoilt by a final line that was not $15x^2 - 12x - 1 = 0$ and these gained 4 of the 5 marks. Most errors occurred in the simplification of $gf(x)$ or $2gf(x)$ and in working that was poorly set out. Incorrect terms in the expansion and simplification of $(3x - 1)^2 + 4$ were quite common. Sometimes only $(3x - 1)^2$ was multiplied by 2. If the composite functions were not labelled as $fg(x)$ and $gf(x)$ then this could be implied by the setting up of the equation $fg(x) = 2gf(x)$ or by multiplying the correct composite function by 2. If labelling was not seen or implied then the answer scored no marks. Students with little or no idea of composite functions interpreted $fg(x)$ as $f(x) \times g(x)$ or started with $15x^2 - 12x - 1 = 0$ and attempted to solve it.

Question 22

This proved to be a challenging question. Many students failed to find a successful strategy and gained no marks. Working out was often messy and difficult for examiners to follow. Students attempting an algebraic approach often started by forming two equations such as $g/(r + g) = 3/7$ and $(g + 3)/(r + g + 5) = 6/13$. To solve these equations students needed to deal with the fractions and eliminate one of the variables and a successful outcome proved to be beyond many. Students who formed the equations $g/r = 3/4$ and $(g + 3)/(r + 2) = 6/7$ had a slightly easier route to a solution. Some students formed only one equation, using either 3/7 or 6/13, and scored one mark only. A different approach used by some students was to form an equation such as $(3x + 3)/(7x + 5) = 6/13$. These students were generally more successful. Some of the students that attempted an algebraic approach were not able to derive the necessary equation(s). Answers of 12 red counters and 9 green counters did not always come from an algebraic approach. Some students realised that the number of counters in the bag at the start must be a multiple of 7 and the number of counters in the bag at the end must be a multiple of 13. Since 5 counters had been added they knew that they were looking for a multiple of 13 that is 5 more than a multiple of 7 and quickly came up with 26 and 21. These students usually went on to score full marks. Many of the unsuccessful attempts were based on using fractions with a denominator of 91 (from 7×13). Since $3/7 = 39/91$ and $4/7 = 52/91$ a common incorrect answer was 52 red counters and 39 green counters. There were many attempts at representing the information in tree diagrams. These were generally unhelpful. It seemed that most students wanted to jump straight to probability tree diagrams and had no other strategies to use.

Summary

Based on their performance on this paper, students should:

- practise working out estimates by rounding numbers and develop an understanding of the purpose of rounding so that they can choose appropriate rounded values
- have a greater awareness of the graphical solution of simultaneous equations
- practise writing clear concise explanations when using the median and measures of spread to compare two sets of data
- learn what is required in a proof as opposed to giving specific numerical examples
- memorise the necessary exact trig values or learn how to work them out

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