Examiners’ Report
Principal Examiner Feedback

November 2023

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

November 2023
Publications Code 1MA1_3H_2311_ER

GCSE Mathematics 1MA1
Principal Examiner Feedback – Higher Paper 3

Introduction

There were some very good scripts from higher attaining students taking this paper and the paper provided the opportunity for lower attaining students to demonstrate positive achievement mainly in the first ten questions. It appeared that most students had been entered appropriately for the higher tier. Students' work was generally clearly and logically presented and examiners were encouraged by an apparent fall in the number of careless errors and misreads seen. Where fully correct answers were not seen, examiners could often award partial credit for correct methods and processes shown in working.

All questions were accessible to some students. Questions 1, 2, 4(a), and 5 were answered successfully by most students whereas questions 11, 15, 16, 19, 22, 23 and 24 attracted fully correct solutions from only a small proportion of students. Questions 3, 9, 11, 15, 18 and 20(b) appeared to challenge a significant number of students working at the targeted attainment level. To balance this, it was encouraging see more students than expected get at least some marks for their answers to questions 19, 21, 22 and 24.

REPORT ON INDIVIDUAL QUESTIONS

Question 1

A high percentage of students showed a good understanding of standard form.
In part (a) the great majority of students were able to convert from the ordinary number to a number in standard form. The most common error was to include the integer 468 as part of the answer. For example, 468×10^3 was often seen.
A slightly smaller proportion of students were successful in part (b) which involved converting a number in standard form with a negative index into an ordinary number. There was no single error which was commonly seen in responses to this part of the question.

Question 2

This question discriminated well between students working at the lower grades. Most students were successful and gained the 2 marks available. However, lower attaining students often divided 200 by 0.4 instead of multiplying. Other responses included cases where 0.4×200 was seen in working but then answers such as $\frac{80}{200}$, 0.8%, 80% and 0.8 appeared on the answer line.

Question 3

This question was also a good discriminator between students working at the lower end of the attainment range. Higher attaining students generally scored full marks. A good proportion of students realised that they needed to use a temperature within each interval in order to calculate an estimate of the mean temperature. Many of these students used the midpoints. However, a significant number of students used the upper

boundaries or other values within the intervals. Some students just added the 5 midpoints and divided by 5 while some other students did get the products of the temperatures and frequencies and added them, but then divided by 5 instead of the total frequency, 50. A small number of students merely added the frequencies and divided by 5 thereby not taking account of the temperatures at all.
Part (b) of the question was not answered as well as part (a) though there were some students who gained no credit in part (a) but who gave a correct response in part (b). There were many clear responses though a significant number of students gave an answer which was either too vague or ambiguous.

Question 4

Part (a) of this question was very well answered with the great majority of students giving clear and concise descriptions of the two mistakes on the diagram. On occasion the vagueness of a statement cost students a mark, for example when they said that one of the circles should be shaded but did not specify which circle. Part (b) was also quite well answered and most students worked accurately to find the critical value. This was more than enough to score the first mark. A surprising number of students left their answer as 4.6 so had not addressed the requirement stated in the question to give an integer. Other students solved the inequality and wrote $y < 4.6$ on the answer line. Students are reminded to read questions carefully and take on board any specific requirements. The overwhelming majority of students who did give an integer answer gave the correct integer, 4.

Question 5

Another well answered question with most students using the common multiple 120 and giving 4 packs and 5 boxes as their answer. Working was generally accurate. Alternative commonly seen acceptable combinations included 8 packs and 10 boxes, 12 packs and 15 boxes and 24 packs and 30 boxes. This latter pairing was given by those students who found 720 (30 × 24) as their common multiple. Very few students used factor trees or Venn diagrams to find a common multiple. Where these approaches were used, they were often not successful.

Question 6

There was a greater proportion of correct answers to this question testing inverse proportionality in a real life context than there has been in previous series. However, there were many students who approached the question using direct proportionality, often obtaining a time of 0.8 hours which may have been seen as unlikely had students carried out a common sense check. 45 machines was also a commonly seen incorrect response coming from $30 \times \frac{6}{4}$ or equivalent.

Question 7

This question testing the use of mixed units of time in the context of distance, speed and time was successfully completed by about a half of all students taking this paper. However, the vast majority of students gained a mark for using time = distance ÷ speed to get the time travelled by car. Unfortunately, the process of changing to consistent units of time defeated many students. In particular, when trying to work in hours and minutes, many students changed 2.6 hours to 2 hours 60 minutes which, in turn, often led them to a final answer of 8 hours, 20 minutes. Another common error was for students to write 5 hours, 20 minutes as 5.2 hours then add this to 2.6 hours to end up with the same 8 hours 20 minutes as their final answer. Teachers might find it useful to help students to recognise that the decimal part of an hour represents tenths of an hour by using a conversion table to emphasise that 0.1 hours = 6 minutes

Hours	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Minutes	6	12	18	24	30	36	42	48	54	60

This may help students to understand that decimal part of an hour × 60 = number of minutes.

Question 8

A high percentage of students were able to use the given formula in this question to work out area, given pressure and force. Fewer candidates realised that their result gave them the area of one face of the cube and that they would need to multiply this by the number of faces before they could compare it with a total surface area of 900 cm^2. Consequently, they compared 144 with 900. Nevertheless, many students were able to do this and gained full marks for their responses.
Hardly any students used an accepted alternative approach, for example comparing 144 with 150.

Question 9

This question produced a good spread of marks. Most students who attempted the question scored at least one of the three marks for forming an equation of the form $y = mx + c$ with 3 in place of c or for substituting their gradient for m. Many students scored full marks for a complete and correct equation. Students scoring 2 of the 3 marks available usually gave the answer $y = 2x + 3$ and had demonstrated a correct method to find the gradient of the line. Examiners did not see equations written in other forms though these would have been acceptable.

Question 10

Students generally started their method to write m as the subject of the formula in one of two ways, either subtracting p from both sides or multiplying each side by 5. Students who did the former were generally much more successful than those who did the latter. Those students who started by multiplying each side by 5 often failed to multiply the p on the right hand side of the equals sign by 5. Students who started by subtracting p usually gave a correct answer in one of the forms $m = \frac{5(k-p)}{2}$, $m = \frac{5k-5p}{2}$ or $m = 2.5(k-p)$.

Question 11

There were very few fully correct answers to this question. Lower attaining students did not appreciate the need to use 50^2 or 100^2 in one way or another to take into account area and unit conversions. These students often restricted their response to working out

$\frac{48\times50}{100}$, resulting in the answer 24. However, examiners were able to give partial credit to the relatively small proportion of students who realised the need to use $1\ m^2 = 10\ 000\ cm^2$, often expressed in the form of dividing by 100 twice. Very few students identified the need to use the scale factor of 2500 (or 50 × 50). Some students successfully chose dimensions for the room on the plan, for example 8 cm and 6 cm then converted these to metres before recalculating the area.

Question 12

About one third of students scored both marks on this question. Students who found the angle for the minor sector were awarded 1 mark. Some students used the formula for the circumference of a circle rather than the area. There were also some students who combined different measures, for example working out the area of the circle then subtracting it from $360^{(\circ)}$.

Question 13

This question was quite well answered and most students gained some credit for their responses. In part (a) there were many correct answers but there were also many students who went no further than using the graph to find the number of plants with a height less than 90 cm. They did not subtract their value from the total frequency, 80 and/or convert their value to a probability as required by the question.
Part (b) and (c) were quite well answered with about half of students giving the correct value for the median and over a quarter of students calculating a correct interquartile range. Those students who attempted part (d) of the question usually gained some credit for their comparison. Examiners needed to see some context in responses, however minimal and this was usually the case. Students who did not provide an acceptable comparison often made a comment which compared the heights of the two data sets rather than the spread or variation, for example, "The plants outside are taller than the plants inside". In some cases, statements were too vague or ambiguous to be considered for the mark.

Question 14

A minority of students scored full marks for their responses to this question. However, many students were able to gain at least one mark and the question was a good discriminator between students who could identify the coefficient of n^2, those who could not get this far and those who went on to get a fully correct expression.

Question 15

The hint in the question given by the ordering of the vertices was lost on most students and this question was very poorly done. Most students were unable to identify the need to compare the pairing of *AD* and *AC* with the pairing of *AE* and *AB* or equivalent. Many students stopped after finding a scale factor between *AD* and *AB* (eg, 54 ÷ 32) and the scale factor between *AE* and *AC* (eg 80 ÷ 21.6). As they got different values, they stopped. There were many erroneous attempts involving "Pythagoras' rule" or areas of triangles. A small number of students who did get two figures to compare did not get the final mark because they did not write a conclusion. Students are advised that drawing two separate triangles and marking in the lengths of the sides may help them to identify and use the similarity of the triangles.

Question 16

Where lower attaining students attempted this question their answers were often restricted to listing the possible numbers for each digit of the passcode without writing down the number of options for each digit. These students could not be awarded any credit. Having said this, the question discriminated well between higher attaining students with each of the possible marks often being awarded. Only a small proportion of students scored full marks for a correct probability. A significant number of students used fractions with denominator 9 in their calculations. They did not appear to appreciate the importance of "Zia tells her friend Amber that..." The most common error leading to the loss of the final mark was for students to include 1 in their list of prime numbers which led to an answer of $\frac{1}{150}$

Question 17

This question also discriminated well between students targeting the higher grades. In part (a) of the question, most students working at this level were able to make an attempt to complete the square. They were often successful and where they did not give a fully correct response, they were often able to get as far as including $(x-4)^2$ as part of their answer. $(x-8)^2$ was an error commonly seen by examiners. An encouraging number of students were able to use their completed square form to write down the coordinates of the turning point on the graph. However, confusion over signs prevented some students from its accurate identification from their completed square form.
In part (b), examiners were surprised that only a minority of students realised that they should use the quadratic formula. The question requested that students give their solutions correct to 3 significant figures and this provided a hint that the equation could not be factorised. Many students did attempt to factorise the quadratic or manipulate the equation in some other way. Despite being given the quadratic formula on the formula sheet, some students used an incorrect version in their working, for example $-b \pm \frac{\sqrt{b^2-4ac}}{2a}$. Some other students replaced the "±" in the formula with "+" and so only found one of the two solutions. There were a good number of fully correct solutions, with most students giving their solutions correct to 3 significant figures. A few students lost a mark as they gave one solution as 0.45 rather than 0.449
The identification of the mistake in Alex's working for part (c) of the question was usually clearly expressed in one way or another.

Question 18

It is disappointing to report that students were generally unable to enlarge the given triangle to the prescribed requirements in part (a) of the question and it was unusual for examiners to be able to award 1 mark for a triangle of the correct size and orientation drawn in the wrong position or for 2 correct vertices. It was not unusual to see the triangle enlarged by scale factor $\frac{1}{2}$ and/or the origin used as the centre of enlargement.
Only a very small number of students were able to give a correct vector in part (b) of the question. A significant number of students were able to rotate and translate triangle

P but seemed not to be familiar with the term “invariant”. Of those students who showed some understanding of the demand, a significant number gave the vector $\begin{pmatrix} 5 \\ -7 \end{pmatrix}$ instead of the vector $\begin{pmatrix} -5 \\ 7 \end{pmatrix}$.

Question 19

Students who were able to use the given formulae for the volume of cones and spheres were able to gain some credit in this question. Many students took advantage of this by showing a correct process to find the volume of the larger cone or of the hemisphere. However, some students found the volume of the sphere but did not halve it to find the volume of the hemisphere. The majority of students realised that they needed to find the radius of the smaller cone in order to find the volume of the frustum, but a relatively low proportion of them were able to use similarity to do this. Instead, students often appeared to halve the radius of the larger cone to find the radius of the smaller cone as 6 cm or to use the volume formula for the cone with the frustum height (5 cm) as the value of h to find the volume of the frustum. Students may find it helps to recognise that the problem involves similarity if they sketch the two cones and annotate them with known dimensions in such cases as this. A significant number of high attaining students scored 4 marks for a fully correct answer.

Question 20

Those students aiming to achieve a high grade were usually able to write down the coordinates of the turning point in part (a) of this question. There were many different incorrect pairs of coordinates seen, with perhaps, not surprisingly (–10, 6) being the most common. Some candidates had apparently not read the question carefully and wrote down the coordinates of the graph given for part (b) of the question.
Part (b) was less well done. Those students who appeared to recognise the transformations needed sometimes carried them out with such inaccuracy that it was not possible for examiners to award any credit. Students are advised in questions like this to consider what happens to specific points before trying to sketch the whole graph. In this question examiners wanted to see the image of the maximum point and endpoints of the graph correctly shown as part of the transformed graph. A very common error was for students to reflect the graph in the x-axis instead of the y-axis.

Question 21

Faced with quite a complex diagram, nearly a half of students achieved some credit for their answers to this question by getting at least one, and often two of the missing angles correct. Angles *ACE* and *ACB* were often found first and examiners were also encouraged to see that a good proportion of students could use the “Angles in the same segment are equal” theorem to state or show on the diagram that angle *CBD* was 35°. Only a small number of these students could accurately quote the theorem to justify their reasoning. A significant number of students stated “alternate segment theorem” but did not state what the theorem is. An error seen commonly in responses from lower attaining students was that of assuming that triangle *CDE* was isosceles, whereas it was in fact right-angled. Students are advised not to jump to conclusions without evidence from the question or diagram to support their assumptions.

Question 22

This question proved to be more of a challenge to the highest attaining students than any other question on the paper but there were still a good number of fully correct responses. Low attaining students often merely substituted values into the word formula without considering bounds. They could not be awarded any marks but of those students who did consider bounds, a large number of them wrote down at least one correct bound from the six bounds relevant to the three values given in the question. Only the best students could identify the correct bounds to use in order the minimise the profit (lower bound of selling price − upper bound of cost of materials). Students who showed a good understanding of the bounds needed for this could usually complete the process to find the lower bound of the hourly rate of pay and use it to give a statement to confirm that Ebony's rate of pay was definitely more than £8.20

Question 23

There was a good number of complete, clear and concise solutions to this question. The great majority of students who attempted this question started by eliminating the fractions and were given due credit for this first step. Most of the students following this approach were able to isolate terms in x and y accurately to get as far as $54y^2 = 150x^2$ or equivalent, then went on to get $3y = 5x$. A small number of students getting this far made an error when interpreting their linear relationship to get a ratio for $x : y$ and wrote 5 : 3 as their answer. The few students who used an approach involving simultaneous equations were usually successful.

Question 24

This question discriminated well between students working towards the higher grades. Many students were able to use the given ratio in order to work out the length of *AP* and so gain the first mark. Only a handful of students awarded one mark out of four were awarded this mark for identifying the angle between *TP* and the base of the prism on the diagram. Significantly fewer students than those who gained one mark showed a correct method to find either the length *MP* or the length *TP* so that they could use trigonometry to find angle *TPM*. Those students who did get that far usually completed the question successfully. Many students mistakenly worked towards finding the size of angle *TPA* and so usually restricted the marks they could be given to 1 mark.

Summary

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

- practice working with time conversions, particularly converting a number of hours expressed in decimal form to hours and minutes
- improve your skills in dealing with the conversion of units in the context of area problems
- ensure you take into consideration whether the gradient of a straight line is negative or positive when you are finding its equation
- practice using the quadratic formula to solve a quadratic equation, particularly when you are asked to give your solution to a certain degree of accuracy.
- remember that when you multiply through an equation or a formula by a constant you must multiply every term by that constant

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