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Examiners' Report
Principal Examiner Feedback

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

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GCSE Mathematics 1MA1
Principal Examiner Feedback – Higher Paper 1

Introduction

This paper gave learners of all abilities a good opportunity to demonstrate their knowledge, skills and understanding. Most of the early questions were generally well answered. Many of the later questions were often not attempted because the majority of learners were targeting the lower grades but there were some good responses to the questions towards the end of the paper from higher attaining learners.

Learners appeared well prepared for topics such as decimal division, fraction arithmetic and indices and there were some pleasing responses to Q6, a problem solving question that involved angles in a pentagon. Many learners were able to give correct explanations in Q2(b) and Q11(a) but the explanations in Q5(b) and Q7 proved to be more challenging. Higher attaining learners generally worked well with surds in Q16 and with functions in Q18. Angles on parallel lines in an algebraic context in Q4, using lengths and volumes in similar solids in Q12 and using circle theorems in Q17 challenged a significant number of learners.

Poor arithmetic often let learners down when they knew the correct process, particularly when negative numbers were involved. Learners should be encouraged to check their calculations and to check the reasonableness of their answers. This would certainly have helped in Q5 where the time taken to travel approximately 5 miles at an average speed of 30 miles per hour ranged from fractions of a minute up to 900 minutes.

Working was generally presented clearly and logically. When answers were not fully correct examiners could often award some credit for correct methods and processes shown in the working.

REPORT ON INDIVIDUAL QUESTIONS

Question 1

Many learners used a formal method to divide a number with the digits 8184 by a number with the digits 12, usually 8184 ÷ 12, and most gained the first mark for making a correct start to the method and getting 6 as the first digit. Some went on to gain all three marks but having worked out 8184 ÷ 12 and obtained 682, many then gave the final answer as 68.2 or 6.82 and gained only two of the three marks. As they had multiplied both 818.4 and 1.2 by 10 before carrying out the division they possibly thought that they needed to divide 682 by 10 or by 100. If they had considered the relative sizes of the two numbers in the question then they should have realised that their final answer was not sensible. Arithmetic errors were common but those 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.

Question 2

In part (a) most learners made a correct start by finding the sum of the four probabilities in the table. Many went on to gain the first process mark, usually for subtracting 0.7 from 1 to find the sum of the two unknown probabilities although a few learners did so by multiplying 0.7 by 350 to find an estimate for the number of times the dice lands on 3, 4, 5 or 6. A good proportion of learners went on to divide 0.3 by 2 to find the probability of the dice landing on 2 but instead of completing the process many gave 0.15 as the final answer and gained no more marks. Some divided 500 by 0.15. Those that did go on to show a complete process gained the second process mark. Arithmetic errors made when working out 0.15×500 meant that the accuracy mark was sometimes lost. After finding the sum of the probabilities in the table some learners divided 0.7 by 2 instead of subtracting it from 1. They gained no marks. Some missed the point about the dice being biased and used $500 \div 6$ to work out the number of times the dice lands on each number.

In part (b) a good number of learners were able to give a correct explanation that the answer to part (a) will be greater or that the number of 2s will increase. Explanations that were not acceptable often stated that the answer to part (a) would change but failed to mention how it would change or stated that the probability would increase. Many of those with an answer of 0.15 in part (a) concentrated on probability rather than the number of expected outcomes. Since part (a) asked for an estimate for the number of times the dice will land on 2, answers in (b) relating to an increase in the probability did not gain any marks.

Question 3

Part (a) was generally answered well. The most common method was to convert both mixed numbers into improper fractions and then write both fractions over a common denominator. Many learners gained at least one of the two marks for getting this far. The accuracy mark was sometimes lost because learners failed to write their answer as a mixed number or made an arithmetic error. Some chose to subtract the whole numbers and deal with the fractional parts separately and those that did were usually successful.

A slightly smaller proportion of learners gained full marks in part (b) compared to part (a) but most gained at least one mark. The question required learners to show that the answer to the division is $2\frac{1}{4}$ so it was necessary for each stage of the method to be shown. Many gained at least two of the three marks for converting both mixed numbers into improper fractions (with at least one correct) and then showing a method to divide by a fraction. It was pleasing to see some learners making the arithmetic more straightforward by simplifying $\frac{21}{4}\times\frac{3}{7}$ to $\frac{3}{4}\times\frac{3}{1}$ before multiplying. Those that wrote $\frac{21}{4}\times\frac{3}{7}=\frac{63}{28}$ had to simplify $\frac{63}{28}$ to $\frac{9}{4}$ or write it as $2\frac{7}{28}$ in order to complete the working and gain the final mark. Having converted both mixed numbers into improper fractions some learners made the arithmetic unnecessarily complicated by choosing to use a common denominator of 12. Some wrote both mixed numbers as improper fractions and made no further progress; some flipped the wrong fraction or flipped both fractions. When no marks were scored this was often because learners had attempted to multiply the whole numbers and the fractions separately

Question 4

This question was not answered as well as might have been expected for an early question on the paper. It is a little different to the usual type of question assessing angles on parallel lines because the sizes of the angles are given with letters rather than numbers. Those learners that earned the method mark usually did so for indicating that angle $ACD = e$, which was often marked on the diagram. Stating that angle ADC + angle $BAD = 180$ was seen less often.

Relatively few learners managed to find an expression, in terms of e, for the size of angle CAD. Some got as far as $4e + x = 180$ but gave this as their final answer or rearranged it incorrectly. The C mark was awarded for an appropriate reason relating to parallel lines and most commonly this was 'alternate angles' to explain why angle $ACD = e$. For this angle, 'corresponding angles' was a common incorrect reason given. A large number of learners failed to gain any marks at all. Some marked angle ABC as $3e$ on the diagram but made no correct progress using angles on parallel lines. Many seemed to think that they needed to find a value for e.

Question 5

In part (a) it was pleasing that a good proportion of learners earned the first mark for rounding 4.96 to 5 or rounding 30.4 to 30 and it was very common to see both numbers rounded. Many went on to gain the second mark for 5 ÷ 30 or for a complete process to find the time. Some of those writing $\frac{5}{30}$ were able to complete the process by multiplying by 60 but many could not. Some started with 30 ÷ 60 = 0.5 and then worked out 5 ÷ 0.5 and another successful approach was to write '30 miles in 60 minutes' and divide both sides by 6 to get '5 miles in 10 minutes'. However, many learners could not demonstrate a full process to find an estimate for the time taken by the car. The first step was often 30 ÷ 5 = 6. Some gave 6 as the answer and others multiplied it by 60. These gained no credit. However, dividing 60 by 6 completed the process and earned the second mark. A significant number of learners did not understand the implications of the word 'estimate' and attempted to answer the question using 4.96 and 30.4. They gained no marks.

In part (b) learners had to decide whether their answer to part (a) was an underestimate or an overestimate and give a reason for their answer. This was answered very poorly indeed. Many learners had rounded 4.96 up and rounded 30.4 down but only mentioned one of these in their answer. Answers such as "overestimate because I rounded the distance up" and "underestimate because I rounded down" were very common. Many learners did not consider how their rounding had affected the actual calculation they had carried out in part (a).

Question 6

It was pleasing that many learners gained full marks for finding the size of angle a. Those that 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 often went on to make further progress. Starting a process to give each angle in a common form earned the second mark and many did this by writing $d = 3c$ or $e = 2c$. Some wrote the angles in terms of a different variable such as x. This was often followed by an equation, e.g. $c + c + 3c + 2c + 155 = 540$, which earned the third mark. Common errors at this stage were to omit one 'c' or two 'c's from the equation or failing to change the given 'a' to 'c' thereby keeping two variables in the equation and not earning the third mark. Many of those with a correct equation went on to give a correct final answer but arithmetic errors, particularly when subtracting 155 from 540 or dividing 385 by 7, were quite common. Learners making these errors could still be credited with the process marks if their intended calculations were shown. After gaining the first mark some learners did not show a process to write each angle in a common form but resorted to a trial and improvement approach and gained no more marks. Those who relied on memory for the sum of the interior angles of a pentagon and stated an incorrect figure were still able to earn the second and third marks.

Question 7

This question was not answered well with many learners unable to explain what the gradient of the graph represents. Correct explanations contained a reference to 'rate' or 'speed' or 'how fast' or 'each second', for example ‘the rate at which the tank is losing water’. Some of the incorrect explanations did refer to the volume of water and to time but described what the graph shows, not what the gradient represents. Explanations such as ‘the volume of water decreases as time increases’ and ‘the volume of water leaving the tank in 50 seconds’ were very common. There were also many incorrect explanations such as ‘negative correlation’ and ‘direct proportion’ that did not mention the context at all.

Question 8

Many learners made a good start, most often dividing 720 by 80 to find the area of the base of the rectangle and this earned them the first process mark. To complete the solution, they needed to divide the area of the base by 2 to find the length of the rectangle. A good proportion managed to work out the length as 4.5 cm and scored full marks. Some lost the accuracy mark due to an arithmetic error, most commonly 720 ÷ 80 = 90, but they could still gain the second process mark for dividing by 2. After finding the area of the base many learners made no further correct progress and some gave 9 as the final answer or multiplied by 2 instead of dividing by 2. It was very common to see $b \times h \div 2$ being used in an attempt to find the length of the base. Presumably this was prompted by the triangular cross section of the prism. Some learners used the pressure formula incorrectly, working out 720 × 80, and gained no marks.

Question 9

In part (a) a good proportion of learners gained at least one mark but there were a large number who knew what a box plot looks like but couldn't find the necessary values from the cumulative frequency graph and scored no marks. Those that had a good understanding usually gained three marks for a fully correct box plot although some lost a mark because of inaccuracies in plotting values. When two marks were awarded for a box drawn and three correctly plotted values these values were usually the lowest mark, the highest mark and the median. Some learners earned just one mark for identifying one of the three values needed which tended to be the median. Box plots with the LQ, median and UQ plotted at 15, 30, 45 or at 20, 40, 60, i.e. quarters of the cumulative frequency or mark range, were often seen.

In part (b) many learners gained one mark for working out 30% of 60 as 18 or for reading a value from the graph at mark = 40 but fully correct solutions were not as common as might have been expected. Some worked out 30% of 60 but failed to obtain a comparative statistic and errors were sometimes made when reading from the graph, most often 44 instead of 42 for the cumulative frequency at a mark of 40. Some interpreted the value 42 read from the graph as the number who passed the test which therefore led to an incorrect conclusion being drawn. A significant number made no attempt to use the graph. It was sometimes not clear whether or not a value had been read from the graph. Learners should be encouraged to show a clear method on the graph if they are reading a value from it.

Question 10

In part (a) a good proportion of learners evaluated both $25^{\frac{1}{2}}$ and $8^{\frac{1}{3}}$ correctly and gave the correct answer of 10. Some gained one of the two marks for either $25^{\frac{1}{2}} = 5$ or $8^{\frac{1}{3}} = 2$. Answers such as $200^{\frac{5}{6}}$ and $200^{\frac{1}{6}}$ were very common and gained no marks.

In part (b) many of the learners who interpreted $\left(\frac{1}{32}\right)^{\frac{3}{5}}$ as $\left(\frac{1}{\sqrt[5]{32}}\right)^3$ went on to gain both marks for a correct answer of $\frac{1}{8}$. Some gave $\left(\frac{1}{\sqrt[5]{32}}\right)^3$ as the final answer and scored just the method mark but the most common route to one mark was to work out $\left(\sqrt[5]{32}\right)^3$ as 8 and then give 8 as the final answer. Those who started with $\sqrt[5]{\frac{1}{32^3}}$ gained the method mark but were not able to complete the arithmetic to get a correct final answer.

Question 11

In part (a) it was pleasing that many learners were able to explain what is wrong with Kate's statement. Correct explanations often stated that the sum of a and b should be 5 and the product of a and b should be 6 and some explained that Kate got the numbers the wrong way around which was also acceptable. Explanations that mentioned just one of the mistakes were accepted but it was not acceptable to simply state that the sum is not 6 and the product is not 5. A common error was to give the correct factorisation and not explain what is wrong with Kate's statement.

A relatively small proportion of learners gained both marks for a fully correct factorisation in part (b) . Many gained one mark for a correct partial factorisation, most commonly $2(m^2 - 1)$ but sometimes this was $(2m - 2)(m + 1)$ or $(m - 1)(2m + 2)$. A common incorrect factorisation that gained no marks was $2m(m - 1)$.

More fully correct factorisations were seen in part (c) than in part (b). Correct partial factorisations such as $x(a + b) - y(a + b)$ gained one mark. The incorrect partial factorisation $x(a + b) - y(a - b)$ was quite common.

Question 12

It was pleasing to see some fully correct solutions but, overall, this question was answered very poorly with relatively few learners showing that they understood the relationships between lengths, areas and volumes in similar solids. Starting the process to find the ratio of the radius of **A** to the radius of **B** by finding $\sqrt[3]{64}$ or $\sqrt[3]{125}$ gained the first mark and some learners reached the ratio 4 : 5. The second mark was awarded for using the information about the radius of sphere **C** and working out 5 ÷ 2 or for starting to work with area and working out 4^2. A process to find the ratio of the area of **A** to the area of **C**, such as $4^2 : 2.5^2$, was needed for the third mark but few were able to get this far. Some of those that did gave 16 : 6.25 as the final answer and were not awarded the accuracy mark because the question asked for an answer in the form $a : b$ where a and b are integers. A successful route used by a few learners was to combine the ratios 4 : 5 and 2 : 1, giving the ratio of the radii as 8 : 10 : 5 from which they could easily see that the required ratio is $8^2 : 5^2$. Many learners could not make a correct start. It was common to see 125, the volume of sphere **B**, divided by 2 and then 64 : 62.5 given as the final answer. Since the question involved three spheres some learners attempted to use the formulae for the surface area or volume of a sphere.

Question 13

There was quite a lot to do in order to work out the value of x so it was pleasing to see some well presented and fully correct solutions. Overall, though, this question was not answered particularly well and many learners failed to score any marks at all. The first mark was awarded for setting up an equation using volumes which could be the first step or it could occur later in the process. This should have been a straightforward mark but many learners failed to set up a correct equation and '+ 142' or '– 142' often appeared on the wrong side of the equation. Some learners only worked with cuboid **A** and it was not uncommon to see the volume of cuboid **A** equated to 142 cm^3. Learners were more successful in gaining the second mark which was awarded for a process to find an expanded expression for the area of one face, where one incorrect term in the expansion of two brackets was condoned. Some went on to earn the third mark for a complete process to find a fully expanded expression for the volume of one cuboid. For this mark the expression could be unsimplified but it had to be correct so errors in their expanding cost some learners this mark. Some of those who had earned the first three marks were able to earn the fourth mark for correctly rearranging the expanded terms in their equation to get a 3-term quadratic.

Question 14

Some learners gained the first mark for stating the value of sin30 or the value of sin45. Those who did not know these values were still able to gain the second mark for a correct sine rule statement such as $\frac{AB}{\sin 45} = \frac{3\sqrt{2}}{\sin 30}$. More than half of those who gained the first two marks did not get a correct final answer, some because they had an incorrect value for sin30 or sin45, some because they could not rearrange their sine rule statement correctly and some because they could not combine the surds correctly. Many learners showed a lack of understanding of the mathematical requirements of the question with some using right-angled trigonometric calculations.

Question 15

Many of the higher attaining learners gained either partial or full credit for their answers to this question and the vector algebra seen was generally clearly presented. Using the information given to write a correct expression for a vector earned the first mark and often this was awarded for a correct expression for $\overrightarrow{OM}$ or $\overrightarrow{ON}$. A good proportion of those that gained the first mark were able to make further progress and earn the second mark which was most commonly awarded for a correct expression for $\overrightarrow{MN}$. Many of those that earned the third mark for correct expressions for both $\overrightarrow{MN}$ and $\overrightarrow{XN}$ did not reach the ratio 4 : 1. Sometimes this was because of errors in the simplification of the expressions found. However, some simplified correctly but gave $\frac{4}{3}\mathbf{b} - \mathbf{a} : \frac{1}{3}\mathbf{b} - \frac{1}{4}\mathbf{a}$ as the final answer. Learners could be encouraged to write expressions such as $\frac{1}{4}\mathbf{a}$, $\frac{1}{3}\mathbf{b}$ and $\mathbf{a}-\mathbf{b}$ on the diagram, with arrows to show their direction, as this may aid their understanding of the direction when combining vectors.

Question 16

Part (a) was answered quite well by those with some understanding of surds and a good proportion of learners gained the method mark for multiplying both the numerator and the denominator by $\sqrt{5}$. Some failed to gain the accuracy mark because they gave $\frac{15\sqrt{5}}{5}$ as the final answer when the question asked for the answer in its simplest form, others because they made errors when trying to write it in its simplest form.

In part (b), writing $\sqrt{75}$ as $5\sqrt{3}$ was sometimes seen as the first step and sometimes it was seen later in the process. Some learners started by writing $\sqrt{75}$ as $5\sqrt{3}$ and simplified the numerator of the fraction to $5\sqrt{3}-2$ but no further progress. Those that realised they needed to rationalise the denominator were not always able to show a correct method to do so. Attempts at multiplying both the numerator and the denominator by $1+2\sqrt{3}$ or by $\sqrt{3}$ were sometimes seen and gained no credit. Some of those that did multiply the numerator and denominator by $1-2\sqrt{3}$ went on to expand the terms correctly but errors were frequently made, often when multiplying $5\sqrt{3}$ by $-2\sqrt{3}$. One error in the numerator or denominator was condoned for the third mark. Those learners who expanded all the terms correctly were usually able to give a correct final answer.

Question 17

Most of the learners who earned the first method mark for finding that angle *CAB* = 40º did so by using the alternate segment theorem. A few found angle *COB* = 80º and then used the angle at the centre is twice the angle at the circumference to find the size of angle *CAB*. Many of those who found angle *CAB* = 40º went on to earn the second method mark for using it to find either angle *OAC* = 10º or angle *OAB* = 30º. The third method mark could be awarded for angle *OCD* = 90º which was often marked on the diagram or for angle *OCB* = 50º and for some learners this was the only mark they got. Complete methods to find angle *ACD* were quite rare. Some that showed a correct method leading to angle *ACD* = 100º and earned the three method marks then failed to correctly state the one circle theorem that was needed for the final mark. Some gave no reason, others gave a description which did not include the required key words. Many learners had no idea how to proceed in this question and misconceptions such as angle *OBC* = 40º and angle *ACD* = 90º were very common. Learners should ensure that they clearly identify which angles they are working with by marking any found angles on the diagram and by using the correct three letter angle notation.

Question 18

Those with some knowledge of inverse functions usually answered part (a) by rearranging $y=\frac{5x-3}{4}$ to make x the subject or rearranging $x=\frac{5y-3}{4}$ to make y the subject. A correct first step in the rearrangement earned the method mark. Many of the learners that made a correct first step went on to give a correct answer but errors in the rearranging cost some the accuracy mark. Following $4x = 5y - 3$ with $4x - 3 = 5y$ was quite a common error. Some completed the rearrangement correctly but gave the answer in terms of y and lost the accuracy mark. A common incorrect answer was $\frac{4}{5x-3}$ because $f^{-1}(x)$ was interpreted by some as the reciprocal of f(x).

In part (b), the most common approach used to work out the value of gh(5) was to work out h(5) = –9 and then work out g(–9). A clear intention to substitute –9 correctly earned the method mark. A surprising number of learners made hard work of evaluating $(-9 - 1)^2$. It was common to see this being expanded to give four terms which frequently did not lead to an answer of 100 or to see $-10^2 = -100$ and these responses earned one mark only. Some found $gh(x) = (1 - 2x - 1)^2$, which earned the method mark, and then substituted $x = 5$. Misunderstanding of composite functions was evident in many answers. Many learners found both g(5) and h(5) and then multiplied them or added one to the other.

Question 19

This proved to be a very challenging question with relatively few learners able to work out the probability of player **A** winning the chess tournament. Some learners were able to make a start to the process and scored the first mark for finding at least one correct product. Often this product was 0.6 × 0.5, the probability of **A** winning against both **B** and **C**, and this was often followed by 0.6 × 0.3, the probability of **A** winning against both **B** and **D.** Most were unable to go on to show a complete process and it was common to see the sum of these two products, 0.48, given as the final answer. Those that multiplied their product by a correct probability, e.g. 0.6 × 0.5 × 0.2, earned the second mark and some were able to go on and show a complete process. The final accuracy mark was sometimes lost because of arithmetic errors in the multiplication of decimals. A common incorrect answer was 0.6 × 0.5 × 0.3, obtained by multiplying the probabilities of player **A** winning against each of the other three players. This incorrect triple product gained no marks. Tree diagrams were often attempted but in many cases these did not help learners to solve the problem because of the unfamiliar nature of this question. Many did not know how to combine the probabilities and often added them rather than multiplying.

Question 20

Very few learners showed any understanding of what was required to answer this question. There were some excellent responses from the most able learners taking this paper but these were few and far between. Some made a successful start by substituting into $x^2 + y^2 = 4$ to find the value of p and earned the first mark but often they made no further correct progress. Some earned the second mark for finding the gradient of the normal/radius or the gradient of the tangent. Mistakes were often made at this stage. Instead of finding the value of p a few learners chose to start by finding the gradient of the tangent in terms of p and then substituted $x = p$, $y = 1$ and the gradient into $y = mx + c$. Finding the value of p then enabled them to complete the solution. Learners should be encouraged to sketch the circle and tangent in questions like this as showing the key values could help them find the gradients of the radius and the tangent.

Summary

Based on their performance on this paper, learners should:

- practise their arithmetic skills, particularly division by a decimal number and negative number arithmetic
- consider whether or not an answer to a calculation is of a sensible size
- practise finding missing angles using angles on parallel lines and giving correctly worded reasons
- know how to calculate the sum of the interior angles of a polygon
- practise using the relationships between lengths, areas and volumes in similar figures
- practise finding angles using the circle theorems and stating the circle theorems used

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