Examiners' Report

Principal Examiner Feedback

January 2023

Pearson Edexcel International GCSE

In Further Pure Mathematics (4PM1)

Paper 01

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Question 1

The vast majority of candidates performed well in this question. However, an incorrect decision in approach taken at the beginning mostly led to only 1 mark or no marks being awarded. The most common incorrect approaches involved unsuccessful attempts to use the summation formula instead of the correct arithmetic term formula, leading to candidates being unable to attempt to solve the equations formed. Another incorrect approach involving not linking all terms algebraically, instead writing, for example, $a_{10}+ a_{11}+a_{12}$ which was impossible to move on from. The alternate method of linking $a_{10} +a_{10} +d+a_{10}+2d$ was equally well answered but rarely seen.

Question 2

In part a, a large majority of candidates were able to find the gradient of *AB* and hence the gradient of the perpendicular. Of these, most then correctly proceeded to find the equation of a line, with a few candidates incorrectly using the gradient for *AB*.

In part b, most candidates followed the first route detailed in the mark scheme, finding an equation for the line *AB* and successfully solving the equations formed simultaneously to find x and y. A smaller number of candidates, substituted either coordinate, usually x, into each equation to show the corresponding value. A minority of students failed to realise they needed to find the equation of the line *AB* and only substituted into the equation of line l.

Part c was generally answered well by those who made at least a reasonable attempt to parts a and b but was often answered poorly by those who'd not made good progress thus far. A good proportion of solutions making good progress were able to use a satisfactory method to show that the line *CD* was not the perpendicular bisector, with many electing to use the longer method involving finding lengths of lines.

Part d was not well done, in general and candidates could be encouraged more to use a sketch for coordinate geometry, where one isn't already provided in the question. Many students did not attempt this part. Of those that did, a sizeable proportion found the lengths of *AC*, *AB* and *BC*, but then assumed this was a right-angled triangle in order to find the required value for tan.

Question 3

Almost all candidates attempted this question and although there was some good work seen, with a sizeable proportion achieving full marks, a larger proportion of candidates achieved no marks at all.

Part a was often not answered well, with many candidates overcomplicating their working to find the value of a. Successful attempts generally picked out the coefficients of x in the expression and set the resulting fraction equal to 4. Others divided each term by x to isolate terms not tending to zero as x gets large. There were a variety of attempts to incorrectly solve an equation. A common incorrect approach led to candidates arriving at $\frac{a}{1} = 4$, leading to an incorrect value being calculated.

Part b was answered well and most candidates stated the correct equation of the asymptote $x = \frac{1}{2}$, although a small number of candidates incorrectly answered $x \neq \frac{1}{2}$

Part c was often well answered, particularly as part i was a follow through mark, using the candidate's value for *a*. Occasionally, the equation was solved incorrectly, giving an answer with an incorrect sign. Part ii was almost universally correctly answered.
However, it was notable that a significant minority of candidates did not label their work in part c or if unlabelled, did not indicate their understanding of which coordinate related to which axis and therefore, failed to gained credit. Candidates should be reminded to always label their work.

In part d, almost all candidates who scored all previous marks continued to sketch the graph accurately. Although follow through marks were available to candidates, trying to sketch the graph with conflicting details with previous errors from previous parts was a challenge. Notable was, few marks were lost due to incorrectly or not labelling asymptotes or points on axes, as required.

<u>Question 4</u>

In part a, most candidates were able to correctly substitute from the given information, find the correct pair of equations and solve these simultaneously. Roughly the same proportion of candidates elected to find *q* or *p* first. Of those who could not show that $p = -2$, many used the given result to find *q*.

Part b often saw candidates scoring full marks. The final mark was sometimes lost either because the x = 1 result was omitted or the candidate failed to change their factorised equation into solutions.

<u>Question 5</u>

In part a, the information provided meant the substitution of the equation for line *l* into the equation for curve *C* was the most efficient way to approach this question. A significant number of candidates rearranged the equation for curve *C* and equated the resulting expression to the equation for line *l*, both methods forming an equation in *x*. Correct rearrangement of the resulting equation led to the formation of a quadratic equation in *x*, with the first method resulting in less manipulation errors in achieving this. Although the choice of methods is essentially the choice of a candidate, candidates could be encouraged to consider the methods available to them to reduce the amount of manipulation required.

Once reaching this quadratic, a number tried to solve it rather than use the discriminant or the fact that there was a repeated root and usually only scored the first 3 marks of the question. A sizeable minority of candidates who'd been successful thus far or found a value for *k*, did then attempt to use the discriminant. A relatively small but notable number incorrectly set their equation to ≥ 0 , highlighting a lack of understanding. It was possible to identify the gradient of the line and find the gradient of the curve. This approach was rarely seen and when used, was not generally successful as the algebra was more challenging.

In part b, a sizeable number of candidates did not arrive at a value of *k* in part a and thus this part was rarely answered fully successfully, except for the most able candidates. Most, having found a value of *k*, realised they needed to substitute to find *y*.

Question 6

In part a, most candidates were able to identify the value of *q*, but many did not correctly identify *p*, the most common wrong value being given was 8.

In part b, many candidates had some idea of how to use the binomial expansion from the formula sheet. However, a minority failed to make use of their *p* and/or *q* from part a. Some candidates attempted to use the formula where *n* is a positive integer, though this rarely led to a fully correct final answer. Candidates should be taught the correct formula, detailed on page 2 of the examination booklet.

A few candidates scored marks for part c, but this was often not attempted. Of those that did, many did not use the correct value for *x*. With some frequency, candidates did not seem to understand that their work in part b was key.

Question 7

In part a, other than an occasional rounding error, there were few wrong values seen in the table and it was incredibly rare to see a candidate scoring anything other than both marks here.

In part b, most candidates were able to plot all points accurately to within the half a square tolerance, correctly joining the points freehand. On occasion, candidates incorrectly plotted, usually a single point, leading to the loss of a mark. Many who had incorrect values from part a, were able to correctly plot these and score one or both marks available. It would be helpful if candidates refrained from circling points plotted and plotted their points with the conventional cross. As in previous exams, some candidates continue to use a ruler to connect their points, though this was fewer in relative frequency. A very small number of candidates attempted to draw a line of bestfit.

Part c saw a large variety of responses. Relatively few candidates were able to score all available marks and there were a sizeable number of blank responses to this part of the question. The most successful approaches followed the main mark scheme. Of candidates successful in taking the first step in using the power law for logs, many were able to continue. Some candidates tried to cube the expression, which didn't help.

After this first step, the use of a change of base formula for logs, or dealing with the negative index when removing logs proved too challenging for many. For those who found the correct line, the mark for the *x* coordinate of the point of intersection was virtually guaranteed. Only a limited number of candidates were unable to plot their $y = 2x + 4$ or gave their answers to more than 1dp, indicating the use of a calculator.

Question 8

A good proportion of candidates were able to complete part a, often making good progress. Where candidates lost marks, they did not know or incorrectly remembered the radian formulas for arc length and area of a sector and attempted to work with the degree formulas. Candidates should be reminded in a "show that" question, they must correctly notate. For example, providing an equation in the form of that given with *P* = rather than Perimeter =.

Most candidates were able to start part b and differentiation attempted was either fully correct or showed some understanding. Most understood the need to equate their resulting expression for the derivative to zero and were able to find a value for *x*, usually demonstrating an understanding that the positive value for *x* must be used to continue. However, demonstrating that this value gave a minimum was not so well understood.

Most candidates were able to gain some marks for part c, the loss of a mark usually being from using an incorrect value for *x*. Not only relative to this question, candidates should always be encouraged to show even relatively simple substitutions, to gain method marks when using incorrect values found earlier in the question.

Question 9

This question provided candidates with a vast array of opportunities in approach, but it was rarely solved fully or correctly, providing a high level of challenge for all but the most able candidates. The most successful method seen was that which made y the subject of both equations as in the main method given in the mark scheme.

Of those attempting this question, many were able to gain the first mark for correctly rearranging the exponential equation and substituting into the second. There were a range of methods seen for this step with some candidates realising rearranging $2y$ as the subject, meant less algebraic manipulation. Incorrect use of laws of logs and exponentials were where most candidates made errors in this question. A common error seen, for example, was $\ln(x + 3)$ written as $\ln x + \ln 3$.

Another fairly common error seen was rearranging $\ln(x + 3) – 2y – 1 = 0$ to $\ln(x + 3) = 2y + 1$, but then failing to correctly raise the whole of the RHS as a power of e. Correct progress beyond this second method mark was rare, unless candidates had correctly gained the first 2 marks, as the resulting equations from incorrect were often difficult to manipulate and misapplication of log and exponential rules continued. An incredibly small number of candidates correctly found x but then failed to find y. There were also a correspondingly small number of candidates who found an incorrect value of x and then used this to find y, sometimes gaining the penultimate mark available.

Candidates using an alternative method were very occasionally successful, but the same errors in misapplying log and index rules were seen.

Question 10

Whilst a significant minority of students failed to gain any marks on this question, of those attempting the question, good responses to part a were often seen. Again, as in question 5, there was a choice of methods available, the most efficient being to form an equation in x and these responses were generally the most successful. Again, candidates could be taught and encouraged to look at which method involves the least algebraic manipulation where a choice is available and, in this case, the demand of the question required only the x values, meaning eliminating y would be the most efficient. A small number of candidates successful in attaining the first 3 marks, failed to gain the final mark as the demand of the question was to find the x coordinate of point A and the x coordinate of point B.

In part b, often, candidates did appear to know the formula for volume of revolution, but sometimes lost a mark by reversing the subtraction. The first 2 marks allowed follow through of incorrect limits from part a. In the main, integration was done correctly. Again, follow through was allowed for an expression of a minimum requirement, to not ease the demand of the question. Most candidates showed the substitution of their limits into their integrated expression, but there are still candidates who could pick up a mark by showing this.

Question 11

Part ai was generally well answered by candidates. Most candidates wrote clear vector paths from A to N, whereas others confused themselves by writing incorrect paths with the corresponding ‘negative’ vector. Candidates could be encouraged to write these paths before finding the required vector in terms of, in this question, **a** and **b**. Those who correctly wrote a vector path usually continued to score full marks.
Part ii was also well answered. Those who did not score the marks generally added both vectors and did not consider the change of direction.

Despite being a common style of question, part b was less well done and there was little evidence this was due to a lack of time, being the end question, as most candidates attempted the question. Only the most able candidates progressed beyond the first mark available, gained by many candidates, to pick up further or full marks. A significant minority of candidates attempting to make progress beyond this first mark chose a path which was indistinct, leading to an invalid solution.

Of the candidates who had distinct routes with distinct parameters, work was often fully correct, or they were at least able to equate coefficients correctly. An unusually large proportion of candidates overcomplicated the final step and substituted their value(s) for the parameter back into their vectors with those parameter(s) to find the required ratio, sometimes leading to processing errors. Most candidates chose to form two vectors for AX, though a wide variety of alternatives were seen, the second most frequent being two distinct paths for vector OX.

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