Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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In Further Pure Mathematics (4PM1) Paper 01R

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Introduction
This paper appeared to have presented a challenge for some candidates. 'Show that' questions, as ever, pose a particular challenge with candidates not entirely certain how much detail is considered sufficient; it is certainly true that many candidates err on the side of less where they should be erring on the side of showing too much.

Having said that, there were also a large number of extremely well answered papers with a pleasing number of candidates scoring well into the 80 + %.
Many candidates understood how to answer this question, using the cosine rule to find one of the angles. However, a surprising minority, given this is pre-knowledge from GCSE, found the demand of problem solving here difficult.

Question 1
Considering this was the first question, it was not as well answered as it should have been. Whilst most candidates understood that they needed to rationalise the denominator and use the respective conjugate, many failed to either read or follow the instruction to work without a calculator. This meant that many candidates thew away marks unnecessarily because the required steps in the working were not shown. If a candidate did not explicitly show the multiplication, particularly in the numerator, they could not score the method marks as it assumed a calculator was used. There were few issues with the final formatting and nearly all candidates did this successfully. Some failed to include the inequality sign but these were few and far between.

Question 2
Again, a surprising number of errors for an early question. The main part of the question required application of the binomial expansion, which is given in the formula sheet. However candidates needed to replace the x in the given formula with Ax, and this was where the first errors were made. There was generally success equating the coefficients of the given expression and the expanded binomial to identify A in terms of n, and the correct substitution of this into the binomial. Some errors were made with the squaring of the $\left(-\frac{1}{3n}\right)$ term which meant that subsequent answers were incorrect. Part (b) was generally well answered, even for those candidates who made errors in part (a), as they were successful in using their answers in the correct coefficient for the cubic term.

Question 3
This Sine and Cosine rule problem appeared to be accessible to the vast majority of candidates but there were still many errors to be found.

Part (a)
This is a show question and in such questions, it is vital to show every single step. Solving a quadratic using a calculator will therefore not be accepted.

It was not uncommon to see solutions to the 3TQ found using a calculator when an algebraic approach **had to be used** and once two solutions had been arrived at, a failure to identify the positive value was similarly seen regularly.

Part (b)
This part was well answered almost without exception.

Part (c)
Whilst it should be noted that diagrams are not accurately drawn, they are approximately correct. Angle *ABC* is clearly an obtuse angle and yet the most common answer to this was 58.7° which only scored the M mark.

This provided a range of errors. Failing to realise that the first answer needed had to be an obtuse angle was very common even though the angle sum in the triangle from calculated answers did not sum to 180. Possibly because candidates did not appreciate that angle sum of a triangle was applicable here, we saw many trying to start from scratch (sine rule) working out the third angle in the triangle. Ft marks were certainly the order for the day in part (c).

Question 4
Part (a)
Generally, candidates were familiar with the radian measure formulae for sector area and arc length; though occasionally candidates were seen trying to use a mixture of radians and degrees. The majority of candidates were able to either replace the arc length PQ giving $r\theta = 21 - r$ or state $\theta = \frac{21-r}{r}$ for the B mark.

Having accomplished that they were then able to substitute either θ or $r\theta$ into the sector area formula. This part of the question was very well answered.

Part (b)
The majority of candidates were able to establish the inequality $\frac{r}{2}(21-r) > 27$. A number of candidates used '=' or could not keep track of the subsequent inequality sign as they processed the resulting 3TQ (especially if negative signs were involved). Most candidates solved their 3TQ by factorising (though the use of a calculator to find the roots was popular). Many candidates could not obtain an acceptable inside region for <u>r</u> and simply quoted the roots as the answer. This part of the question was generally well done, however.

Part (c)
Generally not as many correct answers here apart from stating the resulting values for θ of $\frac{1}{6}$ and 6 after attempting to solve $\theta \geqslant \frac{54}{r^2}$. Not a very successful part of the question for many.

Question 5

This was an algebraic question on the concept of Arithmetic series. Most students attempted this question, and the majority scored well, if not full marks. In addition to the specific knowledge of arithmetic series, the algebraic techniques they needed in this question were solving simultaneous equations and manipulating quadratics. Neither method is easy for candidates at this age when problem-solving with general terms and constants.

Part (a)

Most candidates did well here with many gaining full marks. The formulas used for the sum and the nth term were usually correct, although occasionally the sum formula was incorrect, despite it being given on page 2 of the paper! A common error was to confuse the use of the formulae for *n*th term with the Sum of *n* terms and vice-versa. There were also occasional slips with substituting for *n* (using *n* or (*n* + 1) instead of (*n* – 1) and a few slipped up with sign errors or multiplying out brackets.

We did see the occasional attempt to use Geometric series formulae, but these were very rare.

Part (b)

This was well-answered.

The fact that it was a show that question for both *a* and *k*, alerted many candidates to restart and check their work with correct solutions finally appearing!

Part (c)

A lot of candidates struggled here. Even if they set up their equation correctly with both the LHS and the RHS correct there were a lot of algebraic errors which led to either an incorrect 3TQ or in quite a few cases a linear equation in *n*. We were allowing a correct solution to follow the correct quadratic from a calculator but otherwise a method needed to be shown to secure the method mark. A lot of candidates could have gained a mark by writing out the solution to their quadratic.

Question 6

Many candidates resorted to calculators even though the exact answers were requested for **both** parts.

Part (a)

Candidates had to find the displacements of *A* and *B* and subtract them to find *AB* but a surprising number added them or thought it was enough just to find *B*, assuming *A* was at 0. Some students failed to get both marks by leaving their answers unsimplified as $e^{\frac{\pi}{3}}\sin\left(\frac{\pi}{2}\right)$ Many managed to correctly substitute $t = 0$ but made errors with $t = \frac{\pi}{6}$, which followed over to the length of *AB*.

Many candidates failed to give the exact value either.

It was very rare to see a full and correct solution here.
Others attempted to use Pythagoras theorem in this question, assuming that anything asking for a distance must necessarily involve Pythagoras.

Part (b)
Here, candidates had to differentiate and the only marks available were for correctly treating the expression as a product. Quite a few candidates differentiated the product correctly but not the constant of 2 gaining no marks unfortunately. If they then resorted to a calculator and gave their answer for v as a decimal, they also failed to get the final B1ft. There was some confusion observed between integration by parts and the product rule and that differentiating a constant becomes 0. If the differentiation was correct, a disappointingly few number of candidates gave their solutions as exact values. Had they used their calculators just for $\sin\pi$ and $\cos\pi$ they would have got the exact answer. These should be known of course! Completely correct solutions were not common.

Question 7
This question requires candidates to sketch a graph in part (a) and solve a logarithm equation in part (b).

Part (a)
There were only a few candidates who could score full marks in part (a). Candidates were generally able to find the x-intercept and y-intercept correctly, but there was an exotic array of variously shaped curves or straight lines. The equation of asymptote was particularly troublesome as far as labelling a sketch is concerned. Many candidates clearly have no idea about the primary shape of a log graph. A small number of candidates gave two asymptotes, a vertical one and a horizontal one.

Part (b)
Solving equations using logs in different bases causes difficulty every year, although virtually every candidate scored at least the first mark on offer for changing the base successfully.
While there were a sizeable number of good solutions to this problem, many candidates' attempts left a great deal to be desired. A variety of methods were on offer. Candidates occasionally managed to omit the bracket after getting the square of the log. So, they would think it was the square of $(x + 4)$, instead of the square of the log. It then led them in the wrong direction to solve the question. Another frequent mistake is the candidate only finding the positive value after taking the square root giving 12 as the only solution.

Some candidates used a substitution, many correctly, but some left their solutions in terms of the substitution. Just a few candidates chose to use x for their substitution of $(x + 4)$. There are 25 other letters in the alphabet to choose from!

Question 8

Part (a)

The majority of candidates found AB = 2**a** – 2**b** correctly for the B mark.

Part (b)

The most successful candidates here were the ones who had obviously had some exposure to this type of question; where they understood that obtaining two vector equations for *BX* or perhaps *AX* in terms of two different parameters, subsequently equating the components of vectors **a** and **b** and solving the resultant simultaneous equations was the way to go. Stronger candidates were familiar with this method and were generally successful to show that $BX = kBD$ resulted in $k = \frac{3}{8}$

Generally, vector addition was well understood though weaker candidates often did not appreciate that changing the direction of a vector negated the vector expression. There were many correct answers, using a variety of vectors to compare.

Part (c)

Finding the ratio was a bridge too far for the vast majority of candidates. Knowing not where to begin meant that a large number of blank canvasses were on offer. For those who dared to have a go this was not a very successful question for many candidates.

Considering the simplicity of the solution, it is perhaps surprising how few were able to even attempt this part of the question.

Triangle *CXD*: triangle *ACD* = 3 : 8

Triangle *ACD* : *ABCD* = 5 : 8 then resulting in *CXD* : *ABCD* = $\frac{3}{8} \times \frac{5}{8} = 15 : 64$

The main issue seemed to be candidates getting confused with the ratios involved and perhaps a question involving ratio of areas being an unexpected conclusion to a vector question. We are quite justified in setting these questions as this forms part of 7F in the specification. A tiny number of enterprisingly creative individuals spotted the similar triangles on offer and quickly reached a satisfactory conclusion here. This approach is not strictly speaking a “vector method” but at least there was the satisfaction of solving the problem.

Question 9

This question was generally well-attempted and well-answered, and it was a good source of marks for many.

Part (a)

In this question, candidates were asked to find the equation of a straight line with the given information. It was intended to be an accessible introduction to the question and so it proved to be with nearly every candidate scoring 2 marks here.

Part (b)
Candidates then were expected to use the distance formula between two points and relationship of perpendicular lines to find a point. This was accomplished using either a vector method or the formula, and although we saw less success here than in part (a) many candidates did manage to find the correct coordinates (4, 7).

Part (c)
This part required using the information given together with the equation of the line found in part (a) and the coordinates in part (b) to solve simultaneous equations [one a quadratic, the other a linear equation] to find the coordinates of point *D*.

This part differentiated well between candidates. Most candidates can use the distance formula correctly. It became challenging when it came to the gradient of *CD* or the equation of *CD*. Common errors included using point *A* or *B* instead of *C* and not realizing the gradient should be the negative reciprocal of gradient of *AB*.

Part (d)
Once they find the two points, they needed to find the area of the triangle formed. A simple aid to solution that would have benefitted a majority of individuals was to draw a sketch of the situation that had been presented which would have been particularly helpful in the final part of the problem. Had they done so, they would have realized that *AD* is a vertical line and then the area was simply $\frac{1}{2}\times b\times h$.

However, many candidates, as usual, chose to use the determinant method. Some of them found out triangle *ACD* was a right triangle and use the lengths of *AC* and *CD* to find the area. Only a small minority of candidates realised that *AD* is a vertical line and can use *AD*'s length and distance between *C* and *AD* to solve the problem.

Question 10
Part (a)
This question proved to be challenging with some candidates often able only to gain the first mark or two on offer here. Among the many difficulties encountered was trying to arrive at a quadratic in k^2 and knowing what to do with it. However, even before this, there was evidence of a complete tangle of algebra commonly associated with roots of equations problems, for example $\left(\alpha+\beta\right)^2$, $\alpha^2+\beta^2$ etc.

Many candidates managed to get the first B1 mark but then scoring only one of the next two B marks, however, many who did manage to get both went on to get full marks for part (a). A problem here, seen elsewhere in the paper, was candidates using their calculator to solve a 3TQ and not doing so algebraically, subsequently not identifying the relevant solution correctly.

Part (b)
It was good to see that despite the problems many candidates had with part (a) , this did not put them off to use the given results and tackle this part, sometimes scoring all four marks here.

Many managed to get the mark for the product of the roots and some got it for the sum of the roots in this part of the question. Some, realising that they could work with the numerical value for (b) found earlier marks, progressing to the correct answer which was often visible. Finally, candidates attempting to put together the new equation from new roots often erred with negative signs, expanded brackets needlessly and incorrectly, multiplied through incorrectly to remove denominators from fractional coefficients and omitted zero from their equation. All of these reasons why one or both of the final two marks were lost.

Question 11
Finally, another "show that" problem, this time using trig identities. The biggest issue here was realising how much needed to be written down to constitute an acceptable solution. Centres must encourage students not to try to take short cuts. This certainly caught out large numbers of candidates in part (a). Knowledge of the addition formulae and double angle formulae appeared, on the whole, to be very good.

Part (b)
This, however, was a very different story. A large number of blank pages suggested that candidates either had no clue how to approach this or more likely were running short of time and gave this a miss as it would likely take too long to sort out. Those brave souls who gave it a go struggled to apply the necessary formulae and identities adequately and generally went round in circles. Those who arrived at an appropriate equation in theta promptly rendered it unusable by dividing through by cos(theta) and thereby failing to produce the very equation that was required, $\cos\theta = 0$!!

Part (c)
An alarming number of candidates decided to ignore the constant 2 and omit it from their integral. Moreover, many students continue to fail to show the substitution of their limits explicitly and simply plug values into their calculators. Finally, having got this far successfully, some change a perfectly good exact value into an approximate decimal. Fortunately for them, we ignored the approximate decimal value if we had sight of the exact answer.

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