Examiners' Report
Principal Examiner Feedback

Summer 2024

Pearson Edexcel International GCSE
In Further Pure Mathematics (4PM1) Paper 02R

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Question 1

This question was well answered overall, with the vast majority of candidates knowing the correct approach needed to be successful. Most candidates worked with the discriminant, but some missed the key fact of $b^2 - 4ac = 0$ for equal roots to enable them to get full marks. When substituting values into the discriminant, the negative of b caused some candidates an issue when expanding and simplifying. Candidates are reminded of the importance of brackets in their working as this caused many of the issues seen in this relatively simple question at the start of the paper. Factorisation was the most popular way of solving to find the values of *k*. Candidates could successfully state both the values of *k* from the brackets, and those who had many issues earlier in working were able to gain the M mark here for successful evidence of attempting to solve their 3TQ. There were once again a large notable number of candidates who did not show their working when solving – although some candidates were able to go on to score full marks to a fully correct solution of $k = 9$ and $k = 1$ many who had made mistakes in earlier working and did not show a method to solve needlessly lost the penultimate mark for solving the quadratic as evidence was not seen. Although a calculator is a great tool, it should not be used in lieu of showing the method used to solve. A lot of candidates missed on achieving full marks, and thus did not score the final mark on this question, because they swapped from = to an inequality on the final line of working or had been working on a quadratic inequality throughout.

Question 2

Part (a)

Generally, well attempted, with many candidates were able to express the original expression in power form.

The infrequent errors that did occur came from: losing the negative sign on the index, not including the powers of 3, not multiplying through by 2.

Part (b)

Less well attempted, with $x < \frac{1}{3}$ as the most frequent error.

Question 3

This problem-solving vector question was generally answered better than in previous years with most candidates appearing to know how to approach this question and the steps required, although slopping written working led to not all being successful as they should have been given their approached and methodology.

Part (a)

Most candidates that wrote a correct vector statement for OA or AO and subsequently scored both the first M and A marks. Some candidates did not deal with the subtraction correctly by for example $7i + 2j - (i + 3j)= 6i + 5j$ which although would not lose the first A mark as we allowed an unsimplified vector but did lead to problems later in the question. It is important to remind candidates that they need to make it clear whether they were finding OA or AO, preferably using a vector statement, as some has missing brackets or ended up having the direction of the i and j components opposite to the vector which they confused in subsequent working. A notable number of candidates included the $3\sqrt{5}$ incorrectly in their initial vector statement leading to a loss of marks in this part as they then did not know how to proceed with the rest of the question. For the second M mark there needed to be a clear use of Pythagoras' theorem from their OA or AO vector found leading to a value of a or a^2. The most successful candidates did this efficiently using their simplified expression for OA and promptly arrived at the correct solution with a conclusion and indication of the correct value of a. There were a few cases where candidates did not explicitly acknowledge the $a > 0$ information given in the question and thereby lost the final A mark here.

<u>Part (b)</u>
Most candidates that achieved some $a > 0$ value, usually the correct $a = 3$, and used the correct vector for OA or AO in part (a) achieved this first B mark. However, there were cases where candidates did not make it clear that in their earlier working what their OA or AO and substituted the incorrect a value directly into an unstated, and incorrect unit vector expression and therefore lost this B mark. Candidates are reminded to clearly label their working to enable them to follow their own working. There were a small but noticeable number of candidates who incorrectly used $6i + 3j$ instead of the correct $6i - 3j$ which did not did not enable them to score any marks in this part.

Some candidates in this part then used their OA to calculate the magnitude to use in the unit vector, forgetting this information was given in part a); although this did not preclude them from gaining full marks; it was unnecessary working.

Question 4
<u>Part (a)</u>
A large majority of candidates formed the 2 equations in p and q correctly although a few used f(-2) rather than f'(-2). Some candidates left in the -12q when differentiating.

Having set up the two equations, a significant number of students failed to show the explicit method to find p and q, presumably using their calculator.

A few candidates who didn't know how to proceed, simply used the given value of p to find q, enabling them to continue with the question.

<u>Part (b)</u>
Most candidates used the given factor (x + 5) to factorise the cubic and proceeded to find the 3 linear factors. Both division and inspection were frequently seen. Sign errors were infrequent.

Part (c)
Most candidates went on to give the correct 3 solutions.

Question 5
This question concerned the relationship between Forces, distance and time and involved knowledge of chain rule and was well answered by many.

The first B mark here was really well scored by candidates on this question for identifying $\frac{dr}{dt} = 0.7$.

The most successful approach to the differentiation where those who rewrote the given expression in negative index form and differentiated. Once again there were issue in rewriting which resulted in a large number of candidates attempting to differentiate the incorrect $F = 60r^{-2}$ after not correctly processing the 20 in the denominator. Although there were able to at least achieve the M mark here it did lead to an incorrect final answer where it was not uncommon for candidates to lose the 2 accuracy marks in this question. It was not uncommon for candidates to attempt quotient rule and although it was successfully used by a few candidates there were numerous who incorrectly applied it when attempting to find $\frac{dF}{dt}$. The main issue was the differentiation of the numerator where candidates frequently said (or implied by their quotient rule) the differential of 3 is 1 which resulted in the loss of the 2 marks associated with differentiation.

The M mark for a correct chain rule expression for $\frac{dF}{dt}$ was well answered by many candidates. There was the potential for any to score the subsequent M mark but where there was not the correct expression seen for $\frac{dF}{dr}$, a lack of explicit substitution of r =2.8 seen meant this M mark was lost as a result. Candidates are reminded that explicit substitution should be shown regardless of their working to gain method marks on this paper.
There were many cases where candidates had applied the complete correct working but then missed the final A mark due not giving it in required accuracy. Many candidates left their answer as a fraction thus giving in exact form or dropped the minus sign.

Question 6
Some candidates floundered about in the first stage, often picking up 1 or 2 marks but not working with order and strategy. Many realised what actions were needed but not how to apply them correctly to the equation. Those who did score the first 3 marks almost always went on to score 6 or 7.

A few candidates gave their final answers with incorrect accuracy. A few others misread the graph, giving -1.2 instead of -0.8.

Question 7

Overall, this question was well answered by many candidates, with many were able to score full marks and even the weakest of candidates were able to pick up a couple of marks in part (b) and part (c) even if they didn't get to the correct answer. It was evident from working that candidates are confident and comfortable with the knowledge required to successfully complete this type of question and clear that they have been taught well.

Part (a)

The vast majority were successful at gaining the B mark in this part. A significant number of candidates missed out on the mark as they substituted values in for x, rather than understanding what was meant by the asymptote. As with previous years some confused $x =$ with $y =$ and some omitted this vital part of the answer entirely. For some candidates, this was the only mark they lost in this question, perhaps due to carelessness rather than lack of knowledge.

Part (b)

When differentiating for the equation of l, most candidates used the quotient rule. Those who chose to use product rule were successful the majority of the time, but the usual errors of missing indices where seen. A majority of candidates who attempted via quotient rule, usually scored the M1A1A1 for full correct differentiation but then lost subsequent marks in this question for incorrect processing of the quotient rule. Further expansion and processing of the quotient rule was not required for this question as candidates simply need to substitute the given value into $\frac{dy}{dx}$ to obtain the gradient, which meant some needlessly lost marks in the question for simple arithmetic errors. If candidates were to miss out on marks when differentiating it was for getting their u and v the wrong way round when applying the quotient rule or forgetting to square the denominator.

Even if candidates were not to attempt this question the majority where able to calculate and identify $y = 0$ when $x = -1$ and thus gain the B1 mark in this part.

Most candidates were able to find the gradient of the normal using the negative reciprocal of their gradient found from their $\frac{dy}{dx}$, but it was evident that some candidates did not read the question as they found the gradient of the tangent and lost the final 3 marks in this part. Candidates are reminded of the importance of reading the question and answering what is asked rather than what the perceive the question to be.

Substitution was well done for finding the equation of the line with the vast majority using the approach in the mark scheme. For those who used the $y=mx + c$ approach, this added an extra level of complexity which was not required, and we would advise teachers to reinforce the preferred approach of using $y - y_1 = m(x - x_1)$ to help candidates eliminate unnecessary errors.

Part (c)
Many of the candidates who arrived at a final answer in part (b) were able to score the first M mark for setting their equation of the line equate with the equation of the curve. Many of those were then able to cross multiplying and simplifying their equation to score the second M mark; thus, demonstrating an understanding of how to answer this question.

The main issue for candidates came when attempting to solve their quadratic. Many did not use correct factorising rules, for example fractions in their brackets when there should not have been, or not showing a method at all and simply using their calculator to solve. Candidates are reminded that if a quadratic does not factorise, the quadratic formula is a perfectly valid method to use and evidence of its use should be seen when attempting to solve; use of calculator will not gain method marks as methods must be seen.

Regardless of the value of *x* found, many were able to use their *x*, showing substitution, to score the final M mark in this question. It was not uncommon for candidates who found the correct *x* successfully to go on to score full marks in this part of the question.

Question 8
Part (a)
This part varied from solutions in just a few lines to candidates who wrote a couple of pages without making progress.

Many candidates made the question more difficult by using the sum of terms formulae rather than the nth term ones. This frequently led to higher power equations and extra solutions that needed discounting.

Part (b)
Poorly attempted.

Part (c)
Nearly all candidates knew the formula to use so marks were only lost by those who had an incorrect "*a*"

Part (d)
The majority of candidates used the correct sum formula, with just a few using the nth term instead. Most proceeded through to "n" but a significant number were confused by the inequality. These often lost the final mark and some ended with n = 17. A number of candidates had clearly been taught to use = throughout and they usually gained full marks.

Question 9
This question had three main parts, finding the area under the curve, area of the trapezium/under the line and using these to find the shaded area. The majority of candidates were working with an aim

to subtracting the area under the trapezium away from the area under the curve thus knowing broadly how to approach this question.

On the whole the vast majority of candidates overly complicated this question and did not realise the easiest and most direct approach was to work out the area under the line using the formula for the area of the trapezium; instead, they decided to find the equation of the line and then integrate this. This approach, although completely valid lead to many numerical and algebraic errors which was costly for candidates.

The most successful of candidates kept the area under the curve and area under the trapezium as two separate integrations. Those who tried to combine at the start often made many errors when integrating so would often only score 11000010.

The vast majority of candidates were able to correctly state how to find the area under the curve using integration however some candidates were unable to identify the correct limits from the question or had limits the wrong away around and so failed to score the initial M Mark. Most candidates could successfully integrate the area under the curve or attempt to do this to the required form thus scoring the mark for integrating the curve. Those who went on to show substitution of limits scored the 3rd M mark, but once again a significant proportion did not show substitution and relied on their integration to be correct and a correct final value of the area under the curve to score this mark – it is very risky to take this approach. Incorrectly handled negatives and lack of brackets caused some to miss out on the final A1 mark after substituting in the limits.

It was not uncommon for examiners to see candidates stop at this point and leave the area under the curve as their final answer thus scoring the first 4 marks only.

When finding the area under the line, as previously mentioned, the most common method was to find the equation of the line rather than use the area of a trapezium formula. When finding the equation of the line, many rounded the gradient up to -2, we would assume to appear to be working with exactness, which then caused working errors for the rest of the question. Candidates are reminded that any rounding means that a candidate has lost exactness in their solution and thus will not gain full marks. Candidates also, surprisingly, struggled to integrate the equation of the line, especially in those candidates who were working with exact values. The x outside the brackets causing some an issue in remembering how to handle the denominator. The candidates who found the area under the trapezium by using the formula did better on average than those who tried to integrate.

Only the most competent candidates were able to gain full marks on this question and were rewarded for their exactness throughout. Candidates are reminded to read the question careful which states, find the exact area, so losing exact values when substituting/finding the equation of the line caused them to lose key marks unnecessarily.

Question 10

Part (a)

Generally, well attempted although setting out was often disorganised.

Part (b)

Again, few errors seen with many stating the result after their work in (a).

Part (c)

Usually correct although the majority of candidates used the cosine rule rather than simple trigonometry on the half triangle.

Part (d)

Generally, candidates who knew which angle was required scored all 4 marks while others scored no marks. Many attempted triangles including the vertex. Others made no attempt at this part.

Part (e)

Many correct solutions here but a number of candidates used ½ instead of 1/3.

Question 11

This was probably the question that was fully attempted by the fewest number of candidates in the paper and certainly, it was not very common to see a response that was awarded full marks. It could be due to the fact that it was the last question and candidates perhaps had run out of time at this stage, however it was surprising given that each part of the question was independent to the previous working not to see more attempts or M marks gained. It is timely to remind candidates what not all parts of a question are connected and that if they cannot answer part (a) they should still attempt subsequent parts.

Part (a)

This part was by far the best answered and most attempted section of this question. A greater number of candidates used the correct formula with substitution of $A = B$ into the given formula; a very small number stated the given formula and made no further progress. There were candidates that did not explicitly show the use of $\sin^2 A = 1 - \cos^2 A$ for this attempt leading to the loss of the M mark available here.

There were also many candidates that had shown the fully correct method however did not at any point state $\cos 2A$ in their working and only used $\cos(A + A)$ therefore were penalized for the A mark here. A proof must be complete, including starting expression.

Part (b)

The majority of attempts here did manage to achieve the first M mark with most candidates opting to use the LHS and the identity given in (a), however a lot then failed to see the link between the rearranged version of that identity linking $\cos^2 2A$ and $\cos 4A$ losing the second M and subsequent A mark here.

Similarly with candidates that began with the RHS, the difficulty that appeared to arise when they did not spot the second link between the given identity and the desired form resulting in using other trigonometric identities but errors in subsequent working or deviating too far from the required form.

A common very common error, also, seen here was to initial expand the LHS but then candidates were unable to make any further progress as they did not use appropriate trigonometric to reach the required outcome – this approach almost always resulted in zero marks in this part.

Where candidates worked with both the LHS and RHS thus using a join in the middle proof approach, which is not a suggest approach on this specification but could score full marks, usually failed to score full marks as candidates did not give an acceptable conclusion and were penalized on the A mark available. For this approach, candidates are reminded that a conclusion must be seen for this to be a complete proof.

<u>Part (c)</u>
There were a number of different, correct, approaches seen to this question but by far the most common approach was that which is given in the mark scheme. Only the most able of candidates were able to use a different approach, whether that be chain rule for differentiating $\cos^2 2x$ or using trig identities to arrive at an equation in terms of $\sin x$ only, to solve scored full marks in this part. Most candidates that attempted this part using (b) were able to achieve the first two M marks here; there were a number of errors in the simplifying of the equation of y resulting in subsequent marks being penalised.

Of the many candidates that arrived at correct (or differentiation of the correct form), many did not make further progress in this part. Few candidates used an acceptable identity to deal with the $\sin 4x$ after differentiating losing the B mark here and then did not have a correct method to gain the following M mark available when solving $\frac{dy}{dx} = 0$.

The majority of candidates that did attempt this question is its entirety but were not awarded the A mark for their value of x also ended up forfeiting the penultimate mark due to not showing explicit substitution of their value into y = which was unfortunate for the excellent work seen up to this point at this stage of the paper.

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