Examiners' Report

Principal Examiner Feedback

January 2017

Pearson Edexcel International GCSE
In Further Pure Mathematics (4PM0) Paper 02

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Paper 2

Question 1

A surprising number could not do what was asked, namely to mark coordinates on their diagram, even those who had correct lines. Those who sketched rather than plotted with dashed and numerically labelled axes generally did better but many of the second category failing to label 2.5 on the *y*-axis. Very few of those with correctly placed lines were unable to identify the correct region.

Question 2

The majority of students successfully substituted correctly for $\cos^2\alpha$ in part (a) and went on to show the required identity. Errors included sign slips and arithmetical errors with few mistakes seen in substituting the required identity. Very few seemed to have had no idea how to attempt this part of the question.

In part (b), common errors included miscopying the equation from part (a) with the + sign becoming minus when factorising and solving the trigonometric equation. Many students were able to factorise the quadratic either directly or by more often substituting for the trigonometric function. Beyond this point, while a good number went on to arrive at a correct pair of answers, many found this part of the problem a real challenge and most marks were lost at this stage.

Common errors included rejecting $\sin^{-1}(-0.5)$ because of the resulting negative angle, and not rounding to 3sf for the 60.3° answer.

Part (b) differentiated between moderate and good students.

Question 3

This question was very well answered with many fully correct responses. The process of connected rates of change using the chain rule seems to have been well drilled into students with many clearly set out responses identifying d*r*/d*t*, *A* and d*A*/d*r* before substitution. The majority of students scored full marks, though some failed to give the answer to the specified 3 significant figures and so lost the final mark.

For those who did not score in this question it was generally due to attempting to find the Area when $r = 200$ and then multiply by the 0.5 with no indication of what was representing. There were a few blanks responses seen on this question.

Question 4

In part (a) the vast majority of students wrote down the correct identity for tan 2*x* and then successfully used it to get the expansion of tan 3*x* started. However, this was the point at which a good number stalled although the majority did manage to complete this proof.

Part (b) and consequently part (c) proved more challenging, all there were a great many correct answers. Strongest students would produce model answers in both parts with efficient calculator work. In part (c), those who had correctly found tan α generally went on to correctly evaluate tan 3*x*.

A small number of students lost accuracy in (c) having got $\sqrt{8}$ in (b) and then changed it to 2.83. A significant minority found a decimal answer in part (b) but then failed to use it (c). It was also not uncommon to see the angle worked out in part (b) and left in degrees.

Question 5

Most students showed an understanding that the product rule was needed in part (a), and the first two marks were scored often. However, missing the factor 2 in when differentiating the $(2x\text{-}1)^{1/2}$ term was a common error. The problems tended to lay more in what to do with after the differentiating had been performed. While some were able to carry out the process of putting over a common denominator (usually successfully) others simply jumped to the final answer or ground to a halt.

Though most did attempt the product rule, attempts at the quotient rule (incorrectly) or cases of just multiplying the derivatives of each part (or in one case forming (uv')(u'v)) were also seen with some regularity.

Part (b) was much more successfully attempted, with a majority of students scoring most of the marks. There were some incorrect attempts amidst the many good responses, which usually involved students attempting to solve $\mathrm{d}y/\mathrm{d}x = 0$ rather than use $x = 1$ to find the gradient. In some cases attempts used the "algebraic gradient" never substituting $x = 1$ at all. However, most did find $m = 6$ and proceeded to take the negative reciprocal to find the equation of the normal, though a minority of students found the tangent instead. Almost all the students found $y = 3$ at $x = 1$ (even those using the aforementioned incorrect methods usually had this somewhere in their answer). The procedure for finding the equation of a line was executed very well, and all bar a very few students managed to achieve an equation with integer coefficients.

Question 6

Part (a) was generally very well done by the great majority of students. The main error (from the few seen) was using the sum to 8 terms formula rather than the 8^{th} term formula. There were very few mistakes from students who managed to set up the appropriate equations. There was good algebraic manipulation of the simultaneous equations with a variety of methods quite evenly split between elimination and substitution

In part (b) it seemed that the notation was not properly understood by many students who consequently failed to set up relevant equations. Many responses also showed no attempt. A significant minority equated $5n^2 + 2n$ coefficients to give $A = 5$ and $B = 2$.

Part (c) was very well done. Students most often correctly arrived at $n = 31$, although a few seemed to get confused after getting $n = 30.4$ and then either did not offer an integer value or stated $n = 30$. Most used the $\frac{n}{2}(2a + (n-1)d)$ formula.

Question 7

This was another question where the first part caused a great many problems, but the second part was answered very well. For part (a) the first two marks were achieved by most of the students, but only a few students (no more than 1 in 5) made any further progress. Mostly, beyond this first step students would either incorrect combine the numerator using $a^m - a^n = a^{m/n}$, or would attempt to take logarithms of all terms, or would simply drop the base value as if once the base is common it can be ignored. This resulted in finding an expression for k in x rather than a value for k.

In a very few exceptional cases, students would solve incorrect working to find a value for x and then substitute this back into the original equation and find k successfully. It is unfortunate that such a simple approach of substituting any x value would work, since in no responses I saw did anyone actually do this directly, but in these few cases of substituting following incorrect working, the students were able to pick up full marks without appreciating the situation fully.Where students did manage to successfully complete the question, there was no one particular most common route, but each of the methods in the scheme was seen in use, as well as the method of splitting the expression into two fractions before simplifying each and arriving at the solution.

Part (b), on the other hand, was very successfully attempted by the majority of students. It seems to be another expected question in which the students were well drilled. Most changes the base in $\log_y 2$ term, though a few did change the base in the other term as well. After changing bases the majority did manage to form a correct quadratic equation and go on to solve correctly. There were very few cases of wrong quadratics formed, and where so it was generally due to $3\log_2 y$ becoming $1/(3\log_2 y)$. More of a problem than this was in forming a quadratic at all, with some students only reaching a linear equation.

The final two marks proved a little more problematic, particularly for those students who had solved for $\log_y 2$ rather than $\log_2 y$. The undoing of the logarithms at the end was not as well understood as was setting up the equation at the beginning, with confusion in which way round powers should go (so 2^2 instead of $2^{1/2}$, for instance, was quite common, though the 2^3 was generally done correctly).

Question 8

Generally, part (a) posed little difficulty for the majority of students although many were not entirely certain how to conclude that A, B and C are collinear. There was some carelessness with notation; students did not always take care to differentiate between vector and scalar quantities. Common errors were sign slips when subtracting vectors.

Part (b) was, for almost everyone, probably the most challenging question on the paper, not for the first time. Vector geometry can be a neat way to explain many things but here it was evidently beyond the vast majority of students to use it to find the ratio of the areas required. It was common to see one correct ratio of areas between triangles OAB and OAC but very few students were able to go further than this stage. Completely correct solutions were few and far between and most only gained the B mark at the beginning. There were a lot of no/partial attempts not amounting to very much.

Question 9

The great majority of students scored all marks available in part (a). However a significant number lost the first two marks in part (b), apparently not knowing the formula for finding

the coordinates of *N* when *N* divides *PQ* in the ratio 3:1; some students found the mid-point of *PQ* instead. Those using graphical or direct ratio methods were generally more successful. The method for finding a perpendicular line seemed well understood, with very few students not managing to change the gradient.
Virtually all responses in part (c) gained both marks although the errors may have been made in (b).
Most students demonstrated a good knowledge of finding the area of kite. Some attempted to find the diagonal lengths, then multiplied them to get the area; more attempted the "determinant" method where errors were rarely seen, although accuracy marks could have been lost thorough using incorrect coordinates following earlier errors. The most common failure in method was finding the lengths of each side, then multiplying them together or stopping at that point.

Question 10
In parts (a) and (b) students would quite often take a roundabout way towards these solutions. The fact that the answer was given for both parts almost seemed to make it more difficult for students. There were not many errors seen, but the most common appeared through using the cosine rule, or assuming triangle *ABC* was right angled at *B*.
Part (c) was generally done efficiently and accurately using the method in the mark scheme. Of the few errors seen, the most common was stating *BG* = 15.8. A pleasing number of students kept *MG* in exact form in calculating the final answer.
Where part (d) was attempted it was correct in the great majority of scripts. Only where it was not understood that angle *ACB* = 30^o did errors occur. Only a small minority attempted the cosine rule directly, generally successfully.
A significant number of students having attempted the rest of the question did not try part (e) in a meaningful way. When attempted, the majority found the length *BE* without difficulty. Often this then permitted the student to complete this part of the question correctly.
There were a good number who did not get round to attempting part (e) with incomplete solutions suggesting that some students were running out of time.

Grade Boundaries

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