Examiners' Report

Principal Examiner Feedback

January 2022

Pearson Edexcel International GCSE

In Further Pure Mathematics (4PM1)

Paper 01

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Introduction

This exam series was in a standard time slot, however many of the students had had disrupted teaching due to the extraordinary circumstances over the preceding two years. However, it appeared that the majority of students were familiar with the content of the specification as generally all questions were attempted.

Students should be encouraged to read questions carefully to ensure that they follow instructions such as 'hence', 'using the expression you found in part (a)' or 'use algebra to'. They should also pay attention to any requirements relating to the form for the solution.

Question 1

This question required students to integrate $\cos 4\theta$. This proved challenging for many students with a common incorrect integration being ± sin 4q, with 4sin 4q also seen. Those who did perform the integration correctly, usually went on to score all 4 marks after substituting and evaluating correctly.

Question 2

Part (a) was generally answered well with a good proportion of students being able to make progress towards completing the square and many being able to correctly complete this. Where students attempted to complete the square errors appeared when taking out 2 as a common factor or when moving from $2([x-3]^2-9)+5$ or $2\left([x-3]^2-9+\frac{5}{2}\right)$ to the final answer where multiplication of the constant inside the ( ) by 2 was missed.

Part (b) of the question asked students to 'hence find' the solution to an inequality. Many students did not recognise the significance of the command hence and instead restarted which was condoned on this occasion. A majority of students were able to determine the two critical values for the quadratic inequality, however selecting the appropriate regions proved more challenging. Students might have been more successful in selecting the correct regions if they had drawn a sketch of the quadratic being considered.

Question 3

This was a straightforward question for many students with the majority of responses being fully correct.

In part (a) students were required to use the information about the geometric progression to find the value of the common ratio r and the value of the first term a. Common incorrect answers were because students tried to use an arithmetic progression formula or because they didn't deal with the fractions correctly. A few students found a before r, usually successfully

In part (b) of the question students were told that the series was convergent with sum to infinity S and were asked to find the exact value of S. Most students attempted the correct formula here, even those who had used an arithmetic progression earlier. Some students who had errors in part (a) did not recognise the need for $|r| < 1$ which might have indicated the need to revisit their answer to part (a).

Question 4

Many students were able to make reasonable progress with parts (a) and (b) of this question with good, often correct, attempts at drawing the lines and identifying the region required. Evaluating the least value of P proved more challenging with only a minority of fully correct answers seen.

In part (a) most students tried to evaluate a couple of points for each line, and then joined up on the diagram. A few found extra points; errors, where they occurred, involved poor use of signs. A number of attempts led to there not being a closed region which should have prompted students to check their lines when considering part (b).

The majority of students attempted to shade, or in some other way, indicate a region for part (b) of the question. There were a small number of students who did not use shading to indicate their region which often led to ambiguity relating to the exact region being indicated. Many students were able to follow through the lines that they had plotted in shading a closed region even where errors had been made earlier in the question. For some the lack of a closed region might have prompted a rethink on the accuracy of their lines; it did seem clear that many students expected a closed area to shade in.

In part (c) students were asked to find the least value of P. Using an objective line to identify the point giving the least value of P was rarely seen. Virtually all attempts involved finding points on the graph and calculating the value of P. These points were often vertices of the region (correctly so), though sometimes students seemed to pick a point closest to the vertex which had integer coordinates. Other points were more randomly selected – usually in the region, and occasionally not. P was evaluated for each and the most suitable selected (again arithmetic errors were in evidence). A significant number of students did not attempt this part of the question.

Question 5

Part (a) of the question required students to use the factor theorem and remainder theorem to form two simultaneous equations before solving them to show that $a = 2$ and to find the value of b. This type of question would have been familiar to students and many achieved good marks here. A minority of students assumed a = 2 and only formed a single linear equation restricting the credit that could be awarded. The majority of students who formed correct equations were able to solve these simultaneously without error, although a minority did make mistakes which should have been apparent to them when they failed to reach $a = 2$.

Where students attempted part (b) of the question most used polynomial division successfully. Many were also able to go on to show algebraic working to solve the three-term quadratic that they obtained and give all three solutions to the equation. A minority of students factorised successfully, but forgot to go on to solve f(x) = 0 and give their values of x. Some students did not use algebra in solving the initial equation or to find the solutions to the three-term quadratic, although values from a calculator can often be accepted this was not the case for this question part as the students had been instructed to use algebra to solve the equation.

Question 6

This proved to be a difficult question for many students.

Part (a)(i) was very well attempted. The majority of students were able to identify that they needed to use the sine rule in order to show the given result. Where students attempted the sine rule it was rare that they did not reach the result given. A minority of students attempted to use the cosine rule or assumed that the triangle was right-angled and were therefore unsuccessful in their working.

Part (a)(ii) proved more challenging with many students struggling to show the required result. A common error was to see attempts at using cosine rule, whilst others merely manipulated the given result.

In part (b) students needed to use the ratio given to determine the angle θ before using either of the given results in order to form an equation which they could solve to find x. A reasonable number of students found 45 and those students who reached 45 usually scored full marks. The majority of students worked with the easier sine approach.

Question 7

Part (a) of the question required students to write down the value of $\log_2 16$. The vast majority of students were able to correctly identify that this was 4.

Part (b) of the question required students to apply the laws of logarithms to show that the equation given could be rearranged to $y = 16x$. As is often the case for log questions, there were several successful approaches brought to bear by students. There were also a number of common misconceptions and errors observed.

Students who attempted to change to a consistent base often worked with base 2 which may have been a result of part (a). Only a minority opted to work with base 4 and potentially ended up with the "square of the result" i.e. y^2 = 256 x^2

Many students showed good understanding of how to change base and how to combine logarithms, however there were a number who made slips in working or did not show sufficient steps to fully justify the result given. Students should be aware that they need to be work accurately and show clear steps when justifying a given result for a 'show that' question.

Where errors were seen these were often the common misconceptions relating to the laws of logarithms. For example, errors in changing base, incorrectly combining logs or in some cases treating the logarithm as though it were a multiplier of the terms rather than a function and dividing by this.

Manipulation leading to log y – log x = 4 in base 2 was very commonly seen in a successful attempt. What was evident was the number of students who performed unnecessary / unhelpful (though accurate) steps before returning to a point seen several lines previously and then progressing well.

Part (c) of this question asked students to 'hence solve' an equation. The majority of students did not identify the significance of 'hence' and started from scratch performing the same manipulation as they had in part (b). The minority of students who were able to identify the link between part (c) and the result given in part (b) were fully successful in answering this part of the question. Where students restarted this was allowed and a good proportion of these students were able to find the required solution.

Question 8

This question was answered well by many students with a significant proportion able to produce a fully correct or nearly fully correct answer.

In part (a) the majority of students were able to find a correct expression for h in terms of r, a minority instead found an expression for hr and substituted this instead. Whether the expression for r was correct or not this was usually correctly substituted into the correct surface area formula, although a small minority of students did not use a correct formula. The final mark was lost byu some students as they did not show the full result having omitted S= and at other times for ignoring mistakes in working and just writing the correct expression at the end.

In part (b) of the question students needed to differentiate in order to determine the value of r for which S was a minimum and justify that this value of r gives a minimum value of S. The majority of students were able to attempt the differentiation, with many responses having a fully correct differentiated expression. Most students went on to equate to 0 in order to solve, however there a significant minority of students who had errors in solving for r or showed correct method for solving for r but lost accuracy.

A number of students did not justify that the value of r that they had obtained gave a minimum value of S. Where students attempted to find the second derivative this was often correctly achieved, however some evaluated incorrectly for their r or did not indicate that the second derivative was positive in order to justify that this was a minimum.

Part (c) required students to determine the minimum value of S. Students were often seen to substitute their value of r in order to find a value in this part.

Question 9

Students found this question challenging. Where students were able to make progress with the question this was generally in parts (a) and (c) with few correct attempts or partially correct attempts at parts (b) and (d).

In part (a) students were expected to use a binomial expansion. Students who attempted this part of the question often did so with at least partial success. Errors arose from sign errors and from careless simplification of the cubed term.

Part (b) proved to be very challenging with few students able to show the required result. Some students attempted to use part (a), others gave a decimal evaluation of both the left-hand side and right-hand side and indicated that these were equal, and others performed some manipulation of $\frac{1}{\sqrt{0.96}}$ but did not show any rationalisation of a denominator.

In part (c) students were often able to identify the need to multiply the numerator and denominator by $5\sqrt{6} + 12$, those that did attempt this were generally successful. A common error was to simply give an answer with no working shown, students were directed in the question that they should show their working clearly.

Part (d) was very rarely correctly attempted. It was relatively common to see students simply using their calculator and arriving at 36.37117.

Question 10

Part (a) was generally correctly answered with the vast majority of students able to find $a = 10$.

Part (b) was also well answered. There were many good expositions of finding the equation of a straight line (usually via the use of $y - y_1 = m(x - x_1)$ as opposed to $y = mx + c$). Identifying the gradient of L_1 as 2 and hence finding the gradient of L_2 was equally well done. Some students made errors in their arithmetic.

Parts (c) and (d) were found more challenging by students, however there were still a pleasing number of good attempts seen.

In part (c) those who made meaningful sense of the given information used Pythagoras to form an equation involving m and n, and the gradient of BC to find a second equation. Attempts to form a single equation in one variable proved focussed (generally successful) or over complicated (generally leading to errors of algebra). Disappointingly, simple errors e.g $(m + 3)^2$ expanded to $m^2 + 9$ or $m^2 + 6m + 6$ were seen in a number of responses. The process of moving to a three-term quadratic and solving is well rehearsed; however, students should realise that solving an inaccurate quadratic will not gain credit without a method seen (and calculator solutions are very common).

In part (d) of the question the most popular method for finding the area of quadrilateral is the determinant or shoe-lace method. Again, a lack of written method proved costly for those carrying forward previous errors. Some students failed to appreciate that the area of a shape with 4 points requires 5 columns in the determinant. Many students were able to correctly use this method either with the correct coordinates or following through from the coordinates that they had found earlier in the question.

Question 11

This question proved challenging for students, this was particularly the case for part (b).

In part (a) many students didn't realise they couldn't differentiate this as one term and there were quite a few who used the quotient rule. Some used the quotient rule for $\frac{e^{4x}}{32}$, making a lot of work for themselves but often going on to obtain a correct answer.

Part (b) proved particularly challenging with very few fully correct answers seen and many responses that made no meaningful progress. Where students attempted this part they were often able to correctly identify the integration required to find the volume. Lots of students failed to realise that part a) was giving them the integral and produced a wide variety of different incorrect answers for their integration.

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