Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2025

Pearson Edexcel GCE

In A Level Further Mathematics (9FM0)

Paper 01 Core Pure Mathematics 1

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General

This paper provided plenty of opportunity for candidates to demonstrate what they had learnt. All questions provided access at all levels with questions 7 to10 perhaps being the most demanding questions on the paper, as expected.

It is important for candidates to recognise the importance of using the method asked for in a question. This was particularly true for question 5 where some candidates ignored the required use of method of differences or in question 10 where some candidates did not use what was given.

There were instances throughout the paper where marks were lost unnecessarily.

Examples are:

- question 3 (b) where candidates failed to find all 4 complex numbers
- question 4 where the candidate failed to write $y =$
- question 9 (i) (b) where no conclusion was given

In general, most candidates appeared to be able to complete the paper in the time available with several producing more than one solution for certain questions when they had gone wrong.

Question 1

(a) Candidates needed to be able to determine the values of an unknown in a 3 by 3 matrix that made the matrix singular. They used the method of finding the determinant of the matrix, setting that equal to zero and solving the resulting three term quadratic equation. Finding the determinant using minors of the matrix was by far the most popular and straightforward. An alternative method seen was to use a scalar triple product, but this was only rarely seen.

Most candidates scored full marks on this part with only errors in manipulation resulting in an incorrect quadratic equation and hence incorrect roots.

(b) This required finding the inverse of the given 3 by 3 matrix, given that its determinant was a specified value and that the constant was negative.

The expression for the determinant in terms of the constant a had been found in part (a). However, some candidates instead of using the quadratic expression for the determinant

$-6a^2 + 6a + 12$, used a changed quadratic such as $6a^2 - 6a - 12$ and so could not find a correct value for a. Some candidates did not use the condition for the constant to be negative.

The method for finding the inverse of the matrix with their found constant was well known. There were slips in the signs of some elements of the final answer.

Overall, this proved an accessible start to this paper with many candidates scoring full marks.

Question 2

Candidates were well prepared for this question.

A clear majority chose to use a hyperbolic identity to unpick the equation, rather than the exponential definitions, and overall, the former approach was more reliable and successful. Following the use of the hyperbolic identity, many candidates cancelled out $\sinh x$, not considering that $\sinh x$ could equal zero, and lost the B mark.

There were a variety of ways to find exact solutions to $\cosh x = \frac{3}{2}$ and the formula for inverse cosh was marginally more popular than solving a quadratic in e^x.

Those that did reach $\mathrm{e}^{2x} - 3\mathrm{e}^x + 1$ often then did not take logs and gave their answers as $\mathrm{e}^x = \frac{3 \pm \sqrt{5}}{2}$ scoring only the first two marks since they had to reach $x = \ln\ldots$

There were very few errors in using the logarithmic form for $\mathrm{arcosh}\frac{3}{2}$ occasionally a sign error. The most common mistake at this stage was to forget that $\cosh x$ is symmetrical and therefore miss the negative solution.

Those that went fully into exponentials and tried to solve a quartic equation in e^x struggled to give exact answers as it was tempting to use a calculator and get decimal answers, which received no credit. A few students missed out the $x = 0$ solution by this approach. This approach did however have the benefit of generating two solutions to the quadratic.

Question 3

(a) The majority of candidates were able to rationalise the denominator, collect real parts and eliminate i^2. They continued with an acceptable attempt at showing $a^2 = b^2$. A few failed to collect real parts and forfeited the marks. A small number equated $\frac{z}{z^*}$ to ki and were able to show the required result, with sufficient steps.

(b) Most students were able to find at least 2 solutions. However, many failed to give all 4 solutions. A minority of candidates scored nothing in this part, with most able to at least find a and b and translate into a complex number.

Question 4

(a) Overall students did very well on this question. The vast majority achieved a correct solution to a correct auxiliary equation, with many going on to give the correct complementary function. A few students missed the x term in Axe^{2x} and instead found $y = Ae^{2x} + Be^{2x}$ causing them to lose marks later in part (b).

Most students tried the correct form for the PI and usually proceeded to the obtain it correctly. A few candidates correctly differentiated but then substituted their differentials into incorrect terms. The most common incorrect forms for the PI were $y = \lambda xe^{3x}$ and $y = \lambda x^2e^{3x}$. This cost them the final three marks in part (a). However, they were able to access the first two marks in part (b) if they had a correct complementary function. There were occasional slips made when writing down the general solution. Candidates rarely forgot the $y =$ in their final answer.

(b) Most students who had a correct CF went on to score the marks in part (b), with the majority who had already scored all five marks in part (a), then scoring everything in part (b). There were minor errors when substituting $x = 0$ and $y = 0$ into their general solution, with $5 = A + B + 2$ being seen on occasions.
There were very few mistakes seen in the application of the product rule, though some candidates forgot to differentiate their PI.
Errors were rarely seen in the substitutions of $x = 0$, $\frac{dy}{dx} = 12$ and their value for A.
Occasionally there were errors in the final answer following correct work; sometimes 5 was written for A and occasionally the coefficient of x in one of the exponentials was given incorrectly.

Question 5

This questing required the use of the method of differences which was well understood by candidates. Many scored full marks on this question. Candidates understood the need to split the given fraction into two partial fractions first, and it was rare to see any error in this first step.

The next step of listing the terms in the series was well understood although there were solutions seen where the initial term was found incorrectly using $r = 1$ or $r = 3$ rather than the correct $r = 2$. Candidates usually wrote out enough terms of the expanded series to show convincingly the cancellation of terms. In this case, the minimum was the first two and last two terms. Some candidates gave the terms using the variable r rather than n thus losing a mark.

Having identified the four remaining terms after cancellation, candidates knew how to combine the terms together into a single fraction and proceed to an answer of the required form. There were basic algebraic answers made which prevented reaching the correct answer of $\frac{(3n+2)(n-1)}{n(n+1)}$. The final mark was lost by those candidates who did not give the answer in the exact form specified.

Question 6

This was a well attempted question. It emphasised that candidates should read the entire question before embarking on their solution as some assumed the triangle was equilateral. Those candidates then usually attempted to answer the question using an exponential method for nth roots of a complex number, scoring no marks.

Most students were awarded the B mark for sight of 2 – 4i. They then had to find a real root of the cubic. There were many routes to finding the real root, but the most reliable methods included a sensible diagram.

A sizeable minority of candidates either did not realise that the height of the triangle was 8 and used 4 or instead thought that their height was also the root. There were a few attempts at the use of $\frac{1}{2}ab\sin C$ where students were unsure what they were trying to find.

For students who found the correct triangle height of 3, those that did not go on to find the correct roots of 5 or –1 usually used 3 or -3 as the root, gaining no further credit.

A clear majority of candidates, however, found the real root quickly and efficiently, gaining the first method mark. Where this mark was awarded, students generally went on to score dM1 and ddM1 and very often the A mark unless there were slips in working or only one possible function was found.

Having found the three roots, candidates had the choice of using roots of polynomials or the factor theorem to find the resulting cubic expressions. Candidates had less algebraic work to do if they used the factor theorem and generally made fewer errors with this approach. There were a pleasing number of accurate and well-presented solutions from candidates who used the sums and products of roots, showing that it could be done efficiently.

Question 7

(a) This question differentiated between those who recognised the correct form of the improper fraction and those who did not. Some recognised that there was a constant term but failed to have the correct numerator for their quadratic denominator. Those that had the correct form usually proceeded to find the constants by either equating coefficients, substituting values or a combination of both. A few failed to write out the partial fractions found as required by the question and lost the final mark. A minority had fractions where one was an improper fraction such as $\frac{2x+8}{x+2}+\frac{2x-1}{x^2+3}$ which is not in the required form and needs one more step to separate the improper fraction.

(b) Those candidates who failed to recognise that there was a constant term in part (a) were able to gain some marks in part (b). If they integrated their fractions correctly to achieve $\alpha\ln(x+2)+\beta\ln(x^2+3)+\lambda\arctan\left(\frac{x}{\sqrt{3}}\right)$ then they could achieve the first mark. They could then go on to earn the dM for substituting the limits 0 and 1 and collecting the ln terms correctly. A significant proportion of candidates scored full marks on the whole question although many candidates struggled to collect their ln terms together correctly.

Question 8

(a) This was extremely well answered with many of the candidates able to correctly find the value of A. A common error was candidates incorrectly using degrees mode on their calculator. The other main errors generally came from misreads of the original equations.

(b) This question was poorly answered overall with many candidates not receiving all marks. Most candidates understood they needed an integrating factor and $\operatorname{cosec} t$ was generally found with a minority instead finding $\sin t$. However, a minority could not find either of these. Candidates with $\sin t$ could make little further progress. For candidates with the correct IF the LHS was formed correctly but integrating the expression of the RHS did cause difficulty for some as they were unable to use the correct identities with the "2" often lost. Some candidates left their expressions in terms of A instead of a numeric value until the latter stages though this was condoned if the value was used later. There was a small number of candidates who used the more exact value of A from (a) but again this was condoned. The majority who progressed to integrating remembered to include $+c$ and were able to use the constraints to find a value. Notation in this question for some candidates was poor, although condoned with the integral symbol and dt often not written correctly at each stage.

(c) This question caused difficulties for candidates. Those who were able to start could find at least one root for $\sin t$ and gain the M1. However, many candidates neglected to consider the case $\sin t = 0$. A value of t such as 0, -0.00228... were found by the majority and most then continued onto a correct first positive value π or 3.1438... However, it was noticeable that some candidates omitted these and found the subsequent values by adding 2π. Many candidates who got correct values then failed to write the time as they had not understood the question fully.

(d) Most candidates with a quadratic of the correct form were able to access the question but many unfortunately used rounded figures. The roots for $\sin t$ were generally found correctly but often just written as 1 instead of the more accurate 0.9999.... The use of $\sin t = 1$ was then often seen leading to $\frac{\pi}{2}$ which meant they lost the accuracy mark. A minority of students then went on to write out a time which was not required here. It is worth noting several candidates could not access this question due to not getting the required form from part (b).

(e) This was quite poorly answered even for candidates who had correct values. Linking the values to the context caused issues and some candidates incorrectly talked about later values as opposed to the specific values found in (c) and (d). It was pleasing to see correct comments for incorrect values that were condoned here. But the context caused difficulties with many candidates failing to realise going up the hill should take longer. Some could not articulate their thoughts sufficiently to demonstrate the understanding required for the mark. The most common correct answer was "it should take longer to go up than come down".

Question 9

(i)(a) Many candidates successfully approached this part by correctly substituting the exponential definitions for sinh x and tanh x to form an equation. An equally successful alternative involved multiplying the equation by sinh x before applying the exponential definitions for sinh x and cosh x Most candidates then successfully progressed to derive the correct quartic equation for e^x.

Common errors observed included:

- Missing brackets during multiplication, leading to unmultiplied terms.
- Careless copying from previous lines.
- Incorrect treatment of signs.

A significant number of unsuccessful attempts stemmed from candidates trying to use hyperbolic identities instead of converting to exponential form. There was no discernible difference in outcome based on whether candidates removed fractions early or gradually.

(i)(b) Most candidates confidently substituted $e^x = 3$ or $x = \ln 3$ into each term of the equation. However, a significant majority failed to provide an appropriate concluding statement, which was a prerequisite for earning this mark. A few candidates resorted to using a calculator to solve the quartic, which would also have resulted in the loss of this mark as they never showed evidence of their work.

(i)(c) Most candidates were successful in achieving this mark. The primary reasons for not attaining it included:

- Obtaining an incorrect y-coordinate.
- Stating $x = \ln 3$ and stopping without calculating the y-coordinate.

(ii) This part of the question was significantly more challenging for candidates, with very few scoring any marks. Many candidates unsuccessfully attempted integration by parts, often using several pages without making progress and consequently scoring zero marks.

Candidates who employed substitution in their integration were generally more successful in achieving the correct integral. However, those who changed the limits frequently made errors, such as using an upper limit of "t" and expressing the integral as the limit as "t" approaches infinity, which often led to the loss of subsequent marks. Of those who integrated correctly, candidates who did not use a substitution were more successful in handling the limits and often secured the second method mark. Nevertheless, several candidates simply substituted 0 into their integral. Only a minority of candidates appreciated that $t \to 0 \Rightarrow e^{\frac{1}{t}} \to 0$ to reach a value of $e^{-\frac{1}{4}}$. Very few candidates achieved full marks on this question.

Question 10

This question assessed candidates' understanding of complex number identities, algebraic integration techniques, and modelling using volumes of revolution and density. The question had multiple points of entry for candidates, with many of them being able to gain marks in each part of the question. This question was accessible to most candidates and was a good discriminator of candidates' ability to prove trigonometric identities, manage trigonometric substitutions carefully, and interpret a mathematical model in context. Those who showed methodical working and attention to algebraic detail were well rewarded.

(a) This was generally well answered. Most candidates were able to follow a structured approach to proving their identity, with the majority achieving all marks. Being a proof question, the most common issues related to the accuracy of algebraic manipulation. Sign errors in the expansion of brackets were the most frequent source of lost marks. Other errors included misapplication of powers within the expansion, incorrect use of formulae involving powers of n rather than 1, and occasional omissions of key steps in the proof such as an explicit algebraic expression with grouped terms such as $\left[z^4 + \frac{1}{z^4}\right]$, which were necessary to reach the required identity.

(b) This required the candidates to use the result from part (a) in an algebraic integration to calculate the volume of a solid of revolution. Candidates who correctly applied the volume formula and appropriately substituted the result from part (a) were usually successful. The most common error was the omission of the factor of 8, which appeared in the identity from part (a) but was not always accounted for in the integration. Some candidates failed to recognise that the angle in the expression was $\frac{1}{2}y$ and did not adjust the integrand accordingly. This led to costly mistakes in terms of marks lost.

Other common errors involved the omission of π for the final two marks or dy for the B mark in their integrals. A small number of candidates attempted to derive the integrand independently using double angle identities, with varying success. While a few obtained the correct volume via this route, most introduced errors in sign or expansion, typically leading to incorrect final answers.

(c) This was generally very well answered. Most candidates used their result from part (b) to make a suitable comparison between the calculated volume, the given density, and the provided mass. The most successful responses included the correct use of a density formula and an appropriate conclusion regarding the suitability of the model. Where marks were lost, it was usually because candidates did not have a valid result from part (b) to refer to or did not recall the correct formula for density.

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