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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Summer 2025
Publications Code 9FM0_01_2506_ER*

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.

The paper highlighted that candidates need to recognise the importance of using the method which has been asked for in a question. This was particularly true for question 5 where some candidates did not use the required use of method of differences, and in question 10 where some candidates did not use the statement that was given.

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

Examples were:

- 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

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 it 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 method.

Most candidates scored full marks on this part, with the most common errors in manipulation of algebra, 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 had been found in part (a). However, some candidates instead of using the quadratic expression for the determinant used a changed quadratic such as $6a^2 - 6a - 12$, set it equal to -108 and therefore 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 constant was well known. There were occasional sign slips with elements of the matrix.

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

Question 2

Candidates were generally well prepared for this question.

A clear majority of candidates chose to use a hyperbolic identity to unpick the equation, rather than the use of exponential definitions. The former approach was more reliable and successful. Following the use of a hyperbolic identity, many candidates cancelled out $\sinh x$, not considering that $\sinh x$ could be equal zero and lost a 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 $e^{2x} - 3e^x + 1 = 0$ often did not use logs and gave their answers as $e^x = \frac{3 \pm \sqrt{5}}{2}$ scoring only the first two marks since they needed to reach $x = \ln \ldots$

The most common mistake at this stage was to miss the negative solution.

Those candidates that used exponentials and tried to solve a quartic equation in e^x struggled to achieve exact answers, instead using a calculator to obtain decimal answers, which received no credit. A few candidates also missed out the $x = 0$ solution by this approach. This approach did however have the benefit of generating two solutions to their quadratic.

Question 3

(a) The majority of candidates were able to rationalise the denominator and collect real and imaginary parts. They continued with an acceptable attempt at showing $a^2 = b^2$.

Some candidates failed to collect real parts correctly and forfeited the marks. A small number of candidates 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, having found their a and b and converting into a complex number. However, many failed to give all 4 of the required solutions.

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 $y = Ae^{2x} + Be^{2x}$

Most students used the correct form for the PI and usually proceeded to obtain it correctly. A few candidates correctly differentiated but then substituted incorrectly. The most common incorrect forms for the PI were $y = \lambda x e^{3x}$ and $y = \lambda x^2 e^{3x}$. This cost them the final three marks in part (a). There were occasional slips made when writing down the general solution. Candidates rarely missed writing $y = \ldots$ for their final solution.

(b) Most students who had obtained a correct CF went on to score all the marks 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 a few 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, such as stating the coefficient of x incorrectly.

Question 5

This questing required the use of the method of differences which was well understood by most candidates. Many scored full marks on this question. Candidates understood the need to use two partial fractions, 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 such as 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. Some candidates gave 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 proceeded to an answer of the required form. The final mark was lost by those candidates who did not give the answer in the exact form specified.

Question 6

Most students achieved at least one mark for sight of $2-4\mathrm{i}$. 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 "base" of the triangle was 8 and used 4 or instead thought that their base was also the root. There were a few attempts at the use of $\frac{1}{2}ab\sin C$, where students were unsure of 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 instead usually used 3 or -3 as the root, gaining no further credit.

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 roots of polynomials, 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 form for their remaining partial fractions. Those that had the correct form usually proceeded to find the constants by either equating coefficients, substituting values or a combination of both.

Some candidates failed to write out their final answer in partial fractions and instead listed constants, thus losing the final mark.

A minority of candidates obtained incomplete solutions such as $\frac{2x+8}{x+2}+\frac{2x-1}{x^2+3}$ which is not of the required form.

(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 further marks for substituting the limits 0 and 1 and collecting the ln terms. A significant proportion of candidates scored full marks 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. Errors included candidates incorrectly using degrees to find the answer or from misreads.

(b) This question was poorly answered overall.

Most candidates understood they needed an integrating factor and $\operatorname{cosec} t$ was generally found with a minority instead finding $\sin t$. However, several candidates could not find either of these. Candidates who obtained $\sin t$ as their integrating factor 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 candidates 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 using a numeric value. There was a small number of candidates who used $A = 150.0436....$ but this was condoned. The majority of candidates who progressed to integrating remembered to include $+c$ and were able to apply the constraints to find a value. Notation was used poorly by several candidates, although condoned here; with the integral symbol and dt often omitted.

(c) Candidates with a quadratic of the correct form were usually able to make some progress and could find at least one root for $\sin t$. However, many candidates neglected to consider the case of $\sin t = 0$. A value of t was typically found by candidates and most then continued to a correct positive value of π or 3.1438... However, it was noticeable that some candidates omitted these and found the subsequent values by adding 2π. Many candidates who did obtain correct values then failed to write the required time as they had not understood the question fully. It is worth noting several candidates could not access this question due to not getting the required form from part (b).

(d) Candidates with a quadratic of the correct form were able to access the question. The roots for $\sin t$ were generally found correctly but often written as 1 instead of the more accurate 0.999.... The use of $\sin t = 1$ was then often seen leading to $\frac{\pi}{2}$ which meant candidates lost marks. A minority of students then went on to write a specified 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 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.

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 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
- 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 the 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 of candidates failed to provide an appropriate concluding statement, which was a prerequisite for earning this mark

(i) (c) Most candidates were successful in achieving this mark. The primary reasons for failing to obtain this mark included:

- Obtaining an incorrect y coordinate
- Stating $x = \ln 3$ only, without obtaining the y coordinate

(ii) This part of the question was significantly more challenging for candidates, with very few scoring all marks. Many candidates unsuccessfully attempted this question by using 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. Candidates who used a substitution to change their limits also were less successful in handling their limits and often made little progress. A common approach seen by candidates was to use an upper limit of t and express the integral as the limit as t approaches infinity, which often led to the loss of subsequent marks.

Only a minority of candidates appreciated that $t \to 0^-$ or used similar equivalent language and very few scored the final accuracy mark. Many candidates proceeded from $t \to 0$ to $e^{\frac{1}{t}} \to 0$, without considering the behaviour of $\frac{1}{t}$ or the approach of t from below. Very few candidates achieved full marks on this question.

Question 10

(a) This was generally well answered. Most candidates were able to follow a structured approach to prove the identity, with the majority of candidates who obtained the given answer able to achieve all the 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 marks being lost. Other errors included the misapplication of powers within the expansion and an incorrect use of formulae, involving powers of n rather than 1. There were occasional omissions of key steps in the proof, including the grouping of 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 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 their integration. Some candidates failed to use the expression $\frac{1}{2}y$ consistently and did not adjust the integrand accordingly.

Other common errors involved the omission of π or dy in their integral. A small number of candidates attempted to derive the integrand independently using double angle identities, with varying success. While a few candidates obtained the correct volume via this route, several made sign errors or expanded incorrectly.

(c) This was generally very well attempted. Most candidates used their result from part (b) to make a suitable comparison between the calculated volume, the given density, and the given 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 often 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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