Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2023

Pearson Edexcel International Advanced Level
In Further Pure Mathematics F1(WFM01) Paper 01

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Specification: WFM01

Introduction

This paper proved to be a fair test of student knowledge and understanding. There were many accessible marks available to all students as well as some more challenging questions for higher ability students.

Question 1

The opening question on a straightforward series summation was a good source of marks for an overwhelming majority of students. The correct split was identified by almost all and most proceeded to use the correct summation formulae. Those not scoring full marks tended to just the last mark of the four through poor algebra. A few attempts were seen to equate coefficients which were highly prone to error.

Question 2

This question on complex numbers saw good scoring. The correct conjugate was obtained by almost all and most proceeded to use an appropriate method to obtain a quadratic factor. A few using the sum and product of roots made sign errors. Many went on to obtain the correct second quadratic factor usually by long division or by equating coefficients. A few failed long division attempts were seen where it was clear that students were not well-practised with the method.

Those who had obtained a second quadratic usually solved it appropriately although there were a small number of cases where the "i" was missing from their roots. This question required students to show each stage in their working and those opting to use their calculators (sometimes with unconvincing attempts to reconstruct factors) were penalised.

It was very common to be awarding both marks in part (c). Occasionally the ki roots were seen on the real axis instead of the imaginary axis.

Question 3

This question on a rectangular hyperbola was slightly more discriminating although a considerable number of fully correct solutions were seen. The method was well-known in part (a) with all three differentiation methods seen. Correct application of the perpendicular gradient rule was common with very few working with the gradient of the tangent as they formed their straight line. Most straight-line methods were appropriate although a small number of students seemed a little confused that the answer was not fully given and there was a function of t to be found.

There was a little more to challenge in part (b) although most used $t = 2$ in their normal and substituted appropriately into the equation of *H*. Algebraic processing cost a small number of student some marks here but many obtained a correct quadratic and proceeded to solve it. A common error was not being aware of which of the roots was the right one for where the normal met the hyperbola for a second time and some gave the coordinates of *P*. A few students attempted to solve in terms of *t* which did not prove to be a sensible route in most cases.

Question 4

There was much excellent work seen in this matrix question but it was fairly common to see marks being lost here. In part (i) most knew to obtain the determinant and although it was invariably correct it was often set equal to just 3 and not both 3 and –3.

Part (ii) was the first task on the paper that caused a significant number of poor responses. Many were unable to spot that they needed to find the inverse of matrix **B** although those who did usually obtained the correct matrix. They usually proceeded to multiply appropriately and despite a few algebraic slips, the correct matrix **C** often resulted. Those who could not see the need to obtain $\mathbf{B}^{-1}$ often set up a correct matrix multiplication where they had to obtain the six unknown elements of **C**. Solving the system of six simultaneous equations saw various degrees of progress with many attempts abandoned at an early stage.

Question 5

This question on roots of quadratics saw very good scoring on the whole. Unfortunately a few students ignored the “without solving the equation” instruction and this usually proved rather expensive.

In part (a) the correct sum and product were widely seen although sign errors remain a common pitfall with this topic. Most were able to expand the brackets without error and the correct identity followed by the correct value were fairly widely seen.

It was noticeable that some students did not realise that they could use part (a) in part (b) which sometimes led to needless repetition of work here. The algebraic demands of manipulating the expressions for the new roots were met by most and good scoring was seen for the first four marks. The most common way in which marks were lost were either with sign errors constructing the new quadratic or with students failing to convert their equation into one with integer coefficients as required.

Question 6

Good scoring was seen on this second complex number question but there were recurring errors widely seen across all parts of the question.

Most students made light work of part (a) although some clearly did not know what the modulus of a complex number meant or replaced $|z_1 + z_2|$ with $|z_1|+|z_2|$.

The required method to rationalise the denominator was well-known in part (b) although there were a few cases of students substituting the complex numbers in the wrong places. A few were confused by the form required or lost the denominator of "13".

Those who had progresses to part (c) usually identified that they had to form and solve a pair of simultaneous linear equations. This was usually performed correctly although since every stage of working had to be seen some students lost marks here by calculator use.

Part (d) required the argument of a complex number and the definition was remembered by most. Some performed the arctan with the real and imaginary parts misplaced in the fraction but the main errors here were the giving of answers in degrees or not to the specified number of significant figures.

Question 7

This question explored all three of the numerical methods topics in the specification and again was generally a good source of marks.

Most knew to compute the values at the end points of the interval in part (a) but conclusions were rarely sufficient with many in particular failing to mention that the function was continuous.

The interval bisection technique was widely understood although there were a few cases of students just repeating the work in part (a) by performing a sign change test of the given interval rather than carrying out any bisection. As with part (a), some students lost a mark here through an inadequate or absent conclusion.

In (c), the differentiation was usually correct and Newton-Raphson was often also applied correctly. Some just produced a value here and it is important that students are reminded that they must make their methods clear to the examiners.

Part (d) involved linear interpolation and it was rare to see an incorrect equation set up although there were slips with signs. There were the usual errors with the algebra to find the approximation for the root and these errors were more common with those opting for an equation of line approach.

Question 8

This parabola question proved to be a fairly stern algebraic test although many fully correct solutions were seen.

In part (a) almost all knew an appropriate method to verify that the given point was on the curve although many failed to make the required minimal conclusion.

Part (b) was more challenging but most knew the sensible route to take by finding the gradient of *PQ* and to use it to produce a line equation. $y = mx + c$ approaches led to a higher algebraic demand here as they often do. Most could identify the correct focus but the last mark required fully correct work and this meant this mark was not widely scored. A few alternative approaches were seen but had more mixed degrees of success.

Part (c) proved fairly discriminating although the first four marks were widely scored. Differentiation was usually correct and the straight-line method was correctly applied by most. A common error was to end up with a gradient at Q of $+p$ instead of $-p$. Those who had obtained equations for the tangents generally proceeded to solve to find the coordinates of R but only those who were precise with the algebra were able to produce these coordinates in simplest form.

Question 9

As is common the closing proof by induction of divisibility was very discriminating and full marks were fairly rare despite this one being slightly less algebraically challenging than some seen on earlier examinations.

Many began with testing $n = 1$ instead of $n = 2$. A few did not show any substitution when calculating f(2). Although most knew that they had to consider $f(k + 1)$, the method beyond that was not well-known. Many did not appreciate that they then needed to involve $f(k)$ which led to unsound statements of divisibility for various expressions. All the Ways on the mark scheme were seen to some extent and those who made progress often did not arrive at work which showed clearly that every part of their expression for $f(k + 1)$ had 18 as a factor. It is expected that this is explicitly seen. A full conclusion or narrative was required and it remains the case that some students are unable to provide all the ingredients required to score this mark. For example there must be some indication of "true for $n = k$" implying "true for $n = k + 1$" or this last mark is not scored.