Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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

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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 matrices saw good scoring in part (i) but the two marks in part (ii) were not as widely awarded.

In part (i) (a), most were able to obtain an equation in k using det $\mathbf{A} = 0$, although there were occasional sign slips – usually made when solving a correct equation. In part (b) most could recall how to invert a 2 x 2 matrix correctly. A few students neglected to multiply the adjoint matrix by $\frac{1}{\det \mathbf{A}}$ or they multiplied by det **A**. Answers were also seen with $\frac{1}{\det \mathbf{A}} \times \mathbf{A}$ instead of $\frac{1}{\det \mathbf{A}} \times \mathbf{A}^{-1}$. A few incidences of attempting to substitute the value of k from (a) were seen.

Although there were plenty of fully correct answers to (ii), there were many that were wrong including several confused responses. For example, there were some attempts to apply $\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix}$ and $\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$ to $\begin{pmatrix} p & 0 \\ 0 & q \end{pmatrix}$ instead of stating the values of p and q.

Question 2

This question on complex roots of equations saw very good scoring.

In part (a), the vast majority of students used substitution and invariably arrived at the correct value for p. Occasionally other methods such as long division were used at this stage and these were more prone to error.

The correct quadratic was widely achieved in part (b) and most went on to achieve the correct complex roots, usually with calculator assistance - which was acceptable if the quadratic was seen.

It was surprising in part (c) to see a significant number of students producing incorrect Argand diagrams. In most cases these errors involved plotting real numbers onto the imaginary axis.

Part (d) saw a few errors with Pythagoras. Some attempts did not use the correct shape and involved the distances *PS* and/or *QR*. There were a small number who found the area rather than the perimeter.

Question 3

There was generally good scoring with this question on numerical methods although the correct application of linear interpolation techniques continues to be an issue for some students.

In part (a), almost all knew they had to work out the initial values but some then just concluded that there was a root in the interval or embarked upon interval bisection work. A wide range of equations were seen following applying similar triangles – many succumbing to sign errors. Those who could form a correct equation usually proceeded to a correct answer although this was sometimes given to 3 significant figures instead of 3 decimal places. A small number used a formula or proceeded by finding the equation of the line between the points and these were usually correct. A few responses confused the root with the length of one of the sides of the triangles used.

Part (b) was successful for most, with very few unable to differentiate the expression correctly. Application of the Newton-Raphson method was generally correct but some did not show much method here and if they had wrong values, working needed to be seen to confirm evidence of an appropriate approach.

Question 4

Although there were many fully correct responses to this question on definitions and manipulation of complex numbers, there were a fairly varied range of mark profiles awarded. It remains the case that the concepts of the modulus and argument of a complex number are not always well understood.

In part (a), those who knew the method generally scored all three marks. However, some did not use the correct order of operations and replaced worked out $\left|z^2\right|$ and introduced a 3 $\left(\text{or } \sqrt{3}\right)$ afterwards. Some students continue to confuse the modulus of a complex number with absolute value.

In part (b), full marks were widely scored. The conjugate notation was well known and most then successfully demonstrated the use of an appropriate multiplier to make the denominator real. This needed to be seen explicitly since this question required all stages of working to be seen. A small number left their answer as –6 + 8i instead of 2*z*.

Both marks were commonly awarded in part (c) but there were quite a few incorrect responses. Use of tan instead of arctan was not uncommon. Those who drew a sketch were usually able to produce the correct final angle. A small number of answers were given in degrees rather than radians.

Question 5

There was some confusion seen with this question on the roots of quadratics. A small number started by solving the equation despite it being quite clear in the question that this approach was unacceptable.

A significant number of students assumed that the roots were p and q instead of the reciprocals and they went on to use an incorrect value of pq although it was given in the question. Those who had read the question carefully usually proceeded correctly.

The method required in part (b) was quite well understood and the required algebraic manipulation was handled well by most. It was noticeable that those who were disorganised here often lost marks whilst those with carefully structured work were far less prone to error. Those who had obtained values for the new sum and product were usually able to produce a consistent quadratic although the values were occasionally of the wrong sign or misplaced. An equation was asked for and a significant number omitted the required “=0”.

Question 6

This question on the proof by induction of the power of a matrix saw good scoring on the whole. The method was generally well known although some did not show enough working (often with their substitution for $n = 1$) and there were slips handling the algebra. As remains common, some insufficient or incorrect conclusions/narratives were seen.

In part (b) the correct matrix **N** was often obtained although this was sometimes unnecessarily produced by manual multiplication instead of using part (a). Such attempts often went astray. There were a few cases of slips finding **B** = **NM** and a small number of attempts at **MN** were seen.

In part (c) most realised the need to find det **B** and this was generally performed correctly. The most common error was to go on to multiply the given area by 320 instead of dividing it by 320.

Question 7

A range of mark profiles were seen with this question on summations. Most could expand the sum correctly but there were some careless slips applying the sum of the squares formula even though it is given in the formula book. Most could recall the sum of the integers formula correctly but less well done was the conversion of $3\sum_{r=1}^{n} 1$ with many giving 3 rather than $3n$. Those who had formed a correct unsimplified expression usually progressed to the correct answer.

In part (b) some were unable to use $2n$ for n correctly in the sum of the cubes formula. Some unfortunately persisted with extra terms from part (a). A small number were confused by the fact that the work led to a quadratic in n^2. Many did solve it correctly although the roots were sometimes given as with $n = ...$ instead of $n^2 = .$ It was unfortunate to see $n = \pm 3$ given occasionally as the final answer.

Question 8

This question on proof by induction of divisibility had the usual mixed response.

A significant number of students failed to score the first mark for not adequately demonstrating the divisibility for the n = 1 case. A fairly small number could not recall the method but most knew that they had to obtain an expression for $\text{f}\left(k+1\right)$ and this was usually correct. The full range of possible methods were seen. The most popular route was to form $\text{f}\left(k+1\right)-\text{f}\left(k\right)$ although students sometimes neglected to make $\text{f}\left(k+1\right)$ the subject of the formula. Most of the index work was good overall but sign slips crept in to some solutions. As with Question 6(a), some unsatisfactory conclusions were given. In particular, students are reminded that it is essential for there to be some evidence of true for
$\text{"true for } n=k \underline{\Rightarrow} \text{true for } n=k+1\text{"}$ to access the final mark.

Question 9

There was certainly plenty of challenge in the final question which involved both a rectangular hyperbola and parabola but there were many fully correct and succinct solutions.

The method in part (a) was well-known and the full range of approaches to the differentiation (explicit, implicit and parametric) were seen. Although there were a few who used the tangent gradient, most who attempted the normal applied the perpendicular gradient rule correctly. Most then went on to produce a line equation. The less elegant approach of using $y=mx+c$ remains common and it was a little disappointing to see solutions where "+c" was used despite c being used in the equation of the hyperbola. An intermediate line of working was required before the final answer and this was occasionally not seen.

Progress in part (b) often hinged upon students being able to determine the values for c and t and a significant number were unable to achieve this. There were also confused responses where the normal to the parabola was attempted instead of using the given normal to the hyperbola. Those who obtained values usually proceeded to the correct normal equation and most went on to substitute this into the parabola. There were a few attempts which needlessly repeated the work in part (a). A small number using $4x-30=\sqrt{6x}$ did not make a credible attempt to square both sides. Those who had reached the correct three term quadratic usually could obtain the correct point although two solutions were often offered or the wrong point rejected. Alternative methods using the parametric coordinates of the parabola were extremely rare.

In part (c) it was common to see the correct focus. Those who had completed part (c) generally proceeded to attempt to find the equation of *QR* although it was unfortunate to see some forming the gradient of this line incorrectly. Students who had made it this far usually arrived at a value for the required distance *QS*, many assisted by well-drawn sketches of the graphs. There were a few alternative approaches seen that were often correct with the most popular of these being the use of similar triangles.