Examiner's Report

Principal Examiner Feedback

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Pearson Edexcel GCE Mathematics

In AS Further Core Pure Mathematics (8FM0_01) Paper 1

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Introduction

As this was the first sitting of this paper for the new specification, it was expected that students might struggle with the new content and the different nature of some of the questions in terms of problem solving and modelling. The unstructured nature of question 7 certainly fell into this category and it was clear that the majority of students could not make any significant progress although some very succinct and elegant solutions were seen. Whilst there were clearly some students who had prepared fully for this paper, it was also the case that a significant number of students struggled, as evidenced by the number of blank responses throughout the paper. There were questions that saw significantly more success than others such as question 2 although examiners did identify many examples of poor algebraic processing skills in this particular question. Question 9 was also found to be a very challenging question by many students and it was not clear whether this was due to time pressure or just the nature of this modelling question.

Question 1

This question was generally well done with the majority gaining full marks for (a) and (b).

(a) There were many correct responses many with clear evidence of manual calculation in some cases, although it was expected that students used their calculators. A few wrote each term as a decimal so were unable to gain more than one mark as an exact form was required. Many fully correct answers were seen.

(b) The majority of students used their inverse correctly to find the coordinates using a calculator. Some students chose a manual simultaneous equation method of solution, but this often led to errors. Others seem to have used a calculator to solve the simultaneous equations rather than take the inverse matrix approach.

(c) There was some confusion with the demand here. Some students talked about intersecting lines and others referred to a sheaf or a prism. A few talked in vague terms about transformations and had clearly not understood the question and others left this part blank.

Question 2

This question was a new topic on the specification, though use of the sum and product of roots has been on the IAL specification, but the specimen papers will have been the only previous examples some will have seen.

Most students used the main approach in the scheme for this question and this certainly seemed to be the most effective method. Overall the question was answered really well with the main errors being from basic algebraic manipulation. This has really evidenced the need for students studying mathematics at this level to be competent with algebraic manipulation. There were a number of students who confused their variables though most managed to correct this at the end.

The alternate method posed more problems. This style of answer may be more familiar than the linear transformation and so in time students may learn the best approach to this type of question. Many students used b/a and d/a instead of $-b/a$ and $-d/a$. Again algebraic manipulation lead to lost marks, though not as often as in the main scheme.

Omitting the " = 0" and hence losing the final A mark was rare.

Question 3

(a) The majority of students were able to produce a meaningful diagram with nearly all managing a circle with centre 1 + i

The vertex of the "V" shape varied in position, some had it at the origin and also at various other positions. For those who did have a "V" shape, the directions of the branches also varied, with some pointing both to the left or right. Most students realised that the left hand branch crossed the *y*-axis below the circle although many had the left branch and the circle intersecting at the same point on the *y*-axis.

Irrespective of success with the circle and "V" shape, students almost always knew that they had to shade the area between the "V" and within the circle and so could at least recover a mark following an incorrect diagram.

(b) Proved much more challenging and many students did not know where to start. Those that were able to give the equation of the circle and equation of a half line gained the method marks by attempting to solve simultaneous equations and using the solutions correctly. Some students tried to work with the diagram and find the point of intersection by simple trigonometry but often made false assumptions when doing so. A few considered the triangle with vertices at (2, 0), the centre of the circle and the point of intersection, correctly calculating the sides as $\sqrt{2}$, 3 and $\sqrt{7}$. They were then able to get the point of intersection from trigonometry. A few students left their answer as a decimal rather than a surd.

Question 4

(a) Most students appreciated the strategy needed to solve the problem and use the scalar product to find an angle between the normal vector and the direction of *W*. Unfortunately, many could not then find the required acute angle – a clear diagram would have helped them to visualise which angle was required. A common error was to subtract the result of their inverse cosine from 180°. Those using sine were usually more successful here. A few found the correct angle but failed to give it to the correct accuracy or to indicate degrees or radians and hence lost the final mark.

(b) The majority of students formed the correct parametric form for *W* but many did not then find *CW* and some were attempting a scalar product with a direction vector perpendicular to the plane. There were often errors with signs for those who were working with the appropriate vectors. Those with the correct *CW* were usually then able to accurately use Pythagoras' Theorem to gain full marks here but they were in a minority.

Some of the students who correctly found the value of their parameter, substituted this into the equation of line *W* and found the magnitude of this vector rather than finding the vector *CW* and its magnitude.

Those students who produced a diagram of the situation were more successful. It is perhaps a pity that a number having done fully correct work lost the final mark as they either failed to include units or thought that the units were centimetres throughout.

Question 5

Parts (a), (b), (c) should have been routine procedures and it was surprising how any students made mistakes in these parts.

In part (a), the majority of students realised that the transformation was a rotation but struggled with the angle, whilst many students failed to mention that the rotation was about the origin. A significant number also lost all three marks by attempting to describe a composite transformation.

Part (b) provided mixed responses. Many did state the correct matrix, but a variety of incorrect matrices were also seen - the entries on the wrong diagonals being the most common. The use of a sketch would be advised to help trace where the coordinates (1, 0) and (0, 1) map to under the transformation, and hence help establish the required matrix.

Many students did manage to get full marks in (c) due to the follow through mark, however there was a surprising number who mixed up the order of matrix multiplication and hence gained no marks.

Part (d) was, on the whole, well attempted with only the final mark causing some difficulty. Most students that attempted (d) managed to achieve M1A1ft, although errors in (b) or (c) prevented them getting any further. Students that had gained full marks in (b) and (c) often went on to get the next A mark for finding a correct value for k but not many went on to use the second equation to confirm this, thus losing the final B mark.

Question 6

(a) Many students achieved full marks in this part. Those who did not, often made mistakes in the initial expansion of brackets with $(3r - 2)^2$ seen as $9r^2 - 6r + 4$ a significant number of times. Sometimes the solutions were made far more complex than necessary as students chose to multiply the bracketed expressions out before factorisation rather than looking for common factors first. There were some attempts at proof by induction which in the context of this question generally gained no marks.

(b) This was much less successful for many students. Some substituted $n = 4$ and subtracted to achieve the first method mark but a few substituted $n = 5$ and many did not seem to have noticed the lower limit. The summation of the cosine term caused problems for the majority of students. It was rare to see solutions where the terms of the cosine sum were written out so that students could appreciate the sequence generated. It seemed as though students were determined to use a standard formula to add up these terms rather than look at the problem in a simpler way.

Not all students had the "= $3n^3$" and so never eliminated the cubic term to achieve a 3 term quadratic. Those that had a 3 term quadratic were usually able to earn the method mark for solving it. Of those with the correct solutions, most correctly identified $n = 29$ as the final answer.

Question 7

This proved to be a very challenging question, and a significant number of blank or very low scoring attempts were seen. Many students produced work worthy of the first mark (many achieved it several times over) but failed to make progress beyond this – either going round in circles or making wild assumptions.

Most recognised that an equation could be formed in terms of the area of the triangle but the bigger challenge was to find another way into the question, i.e. by using the sum of roots or, occasionally by dividing the polynomial by $(z – 3)$, although very few recognised that they could solve the quadratic and hence find the other two roots.

Most successful students realised that the other two roots needed to be a conjugate pair and then were able to use the sum of roots to find the real part. Many diagrams did not show a conjugate pair so the method to find the imaginary part using the area of a triangle was not always successful. Those that found values for the real and imaginary part of the other roots were able to find values for p and q. Many used the method in the scheme, but some multiplied out (z – 3)(z – "(–2 + 7i)")(z – "(–2 – 7i)") successfully.

Many who tried the alternative approach divided successfully by $(z – 3)$ but were unable to use the quadratic to any great effect. Drawing a diagram certainly helped in this question.

Question 8

Mathematical induction is a well-known topic and though the new specification may introduce some different induction proofs, the two in this question should have been familiar to students. Nevertheless, mathematical induction continues to be a topic that confounds many students. Of the two parts, part (i) proved more accessible.

Part (i) was a standard proof using 2×2 matrix multiplication and most students knew the steps well. Some did not show the $n = 1$ case clearly and lost the first mark. Some made slips in the multiplication of terms and many did not write the final matrix in terms of $(k + 1)$, leaving the examiner to interpret that the final matrix was of the required form. The final statement was usually clear but some did not make the 'if true for $n = 1$ and $n = k$ then… clearly enough.

Other errors in part (a) included basic algebra errors and in a small number of cases attempting to find $M^{(k+1)}$ by incorrectly using $M^k + M$.

Part (ii) was less well answered. Most students achieved the first three marks for showing

$n = 1$ is true, stating the assumption and attempting $f(k + 1)$, but a large number struggled to go any further. Of those that did manage to correctly obtain an expression that contained $f(k)$, the majority went on to achieve full marks, though some that used way 1 or 3 did not find a correct expression for $f(k + 1)$ alone. All four methods were used with none standing out as being the most successful.

Question 9

This proved to be a challenging end to the paper, with signs that some students were struggling to finish in time, although some blank responses may have been due to students simply not knowing where to start. Contextual questions are a necessity on the new specification, so students will have to get used to tackling them.

Part (a) did prove accessible to most students, with some degree of progress being made. Many achieved both marks for correct values, though some did make slips in simplification of some terms. A few did not correctly associate the coordinates, but did at least try to engage with the question.

Part (b) tested the understanding of volumes of revolution in context and many failed to correctly identify the cylindrical parts of the bottle that were needed to form the overall shape. Many omitted these altogether, while others attempted a single cylinder down the centre. Another popular error was to attempt to subtract a cylinder from the solid formed from the rotation of the curve.

Most were able to form the correct follow through expression for their answers to (a), but many did not use the correct limits in the context of the question, with 0 and 4, or 1 and 4, being very common choices. There were also many who attempted a volume of revolution about the x-axis, who could gain no credit other than for the cylinders (if they found them).

Even the integration proved somewhat problematic in that some students did not show their working. Presumably some students used their calculators to perform definite integration but it should be emphasised that in questions such as these, full working should be shown. Those who did show the working for the integration mostly did acquire the method mark, and those with correct a and b consequently gained the accuracy too.

Putting the volumes together was successfully achieved by those who did work out the correct portions that were needed, though some students omitted the π on the integral. For many, failure to correctly identify the two required cylinders lost the final two marks of this part.

Part (c) saw a wide variety of answers, many suitable to access the mark. However, a common response was to state the bottle may not be full, which did not score as it is not a limitation of the model. Students need to understand that a limitation of the model needs to refer to a feature of the model, such appropriateness of an equation used, or any aspects that may affect its suitability to be used.

Part (d) was not as well answered. There was perhaps some confusion as to the difference between a limitation and an evaluation of the model, with some students again referring to a limitation here. It was important that a comparison be made here, and there was no need to offer a reason why it may or may not have been appropriate, but simply to have drawn a conclusion from the comparison as to whether the model is suitable or not. An appreciation that the label should be an under-estimate of the true volume, so that the bottle could contain this amount with some room to spare, was not shown by many students. Those students who answered correctly here mainly focussed on how far out (with specific reference to “greater than”, “less than”), their value was from the stated volume and hence made an evaluation of the model.

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