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General Certificate of Education

Mathematics 6360

MFP4 Further Pure 4

Report on the Examination

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General

Just over 1000 candidates sat this paper and the overall standard of the candidature was generally very encouraging. It is apparent that many comments made in earlier reports have filtered their way through to candidates, as there were several places in which thoughtful comments were required and these were handled both purposefully and with competence by the majority of candidates. Much better use was made of the results in the formulae booklet, and there seemed to be a greater awareness of how different ideas tied together, and also a great deal more imagination and flexibility in handling ideas which have previously proved themselves to be great stumbling-blocks. Unlike the scripts seen on January 2009's paper, examination technique was much more evidently at the right level, which confirms the view that many candidates were entered too early in January, at a time when their mathematical ideas had not matured sufficiently to be 'exam-ready'. Examiners cannot recall any candidate having difficulty presenting full attempts (to the extent that their ability would allow) at all the questions, so the length of the paper would seem to have been well judged. There were many candidates who managed to score 60 marks or more and relatively few who scored under 30.

Question 1

This was a straightforward starter to the paper, and was generally found to be so by candidates. Almost all candidates knew what to do, in principle, although there were unexpectedly large numbers of arithmetical (particularly sign) errors in part (b) when finding the required value of k.

Question 2

This was another fairly basic test of the results, given in the formulae booklet, relating to the matrices of 3-d transformations, and was mostly handled very well. Apart from a small minority who made elementary mistakes with the matrices for A and B, the most common error was in taking 'A followed by B' to be represented by the product AB rather than BA. A few candidates mistakenly described the reflection as being in the $y = z$ plane when they really meant the y-z plane. In marking part (b)(ii), the error of describing $x = 0$ as a line rather than a plane was overlooked. Follow-through marks were allowed for those who had multiplied AB rather than BA but in **no** other cases.

Question 3

This was the first question on the paper which required some explanation by candidates, to justify their working in some way or to explain their results. Although responses were a *lot* better than they generally have been in the past, there is still much scope for improvement. In particular, candidates need to realise that, when the answer is given in the question, they need to be a little more diligent in its justification. This especially applies to the better candidates, who can frequently "see" things as obvious or work them out "in their heads". Sloppy presentation of solutions can often lose these candidates marks. In part (b), the question tells them that the line and plane do not intersect. Even amongst those who substituted the given line equation into the correct plane equation, and found a contradiction of the "$-2 = 4$" variety (see the mark scheme), very few offered a satisfactory explanation of the non-intersection. A small number of candidates took the slightly less obvious approach of showing that the line was perpendicular to the plane's normal; however, this did not, on its own, establish that the line didn't lie *in* the plane, and an extra step was needed in order to gain all four marks here.

Question 4

This proved surprisingly tough for most candidates. The work is a three-dimensional extension of the linear simultaneous equations work found at GCSE level, yet the majority of candidates found the algebra too tough for their liking. Part (a) was usually handled competently, but part (b) elicited a great range of responses, possibly because of the extra layer provided by requiring recognition that $(x', y', z') = (x, y, z)$ for invariant points. Many candidates had no idea what to do with the three expressions given in the right-hand column vector and generally, explicitly or by default, took it to be equal to $\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$ before attempting to solve. Even then, very few gained the correct follow-through answer.

Question 5

This was the most straightforward question on the paper after question 1 and was generally handled very successfully by candidates. A few slips arose in the evaluation of scalar and/or vector products, and some candidates found the volume of the parallelepiped defined by O, A, B and C rather than A, B, C and D in part (a)(ii). Candidates who found the volume to be negative were penalised.

Question 6

This question required several different ideas. In part (a), it was essential to use the word "area" to describe the significance of $\det \mathbf{M}$ in relation to T, although responses were much more frequently appropriate in this respect than had been the case the last time such a question appeared. A similar type of comment was required at the end of part (b). In part (c), those who parametrised the line as $(x, \frac{1}{2}x + k)$ generally coped very well, although a significant number lost the final mark by not showing the necessary working to support the given answer carefully, as opposed to merely stating what had been stated in the question. Responses to part (d) proved extremely puzzling: candidates were told that the transformation was a shear, so it was rather strange to find so many including descriptions of (often multiple) stretches, enlargements, rotations and reflections. Candidates are encouraged to look at the mark scheme to find ways in which shears can be described.

Question 7

The more confident candidates found this question to be a source of easy marks. The real difficulties arose in part (b) due to a widespread inability to use brackets and deal with minus signs. When candidates wrote -3^n when they actually meant $(-3)^n$, and it was necessary to read on to see what they eventually did with the terms involving powers of (-3). The standard approach appears in the mark scheme, though the alternative algebraic ones also appeared quite often, and these were much more pleasing to the eye. For n even, noting that $\mathbf{D}^n = 3^n\,\mathbf{I}$, we have $\mathbf{M}^n = 3^n\,\mathbf{U}\,\mathbf{I}\,\mathbf{U}^{-1}$, which gives the required result both obviously and quickly. However, a small number attempted this approach, but wrote something along the lines of $\mathbf{M}^n = \mathbf{U}\,\mathbf{D}^n\,\mathbf{U}^{-1} = \mathbf{D}^n\,\mathbf{U}\,\mathbf{U}^{-1} = \mathbf{D}^n$ first. This is wrong and scored 0/3. For n odd, a similar 'shortcut' arises via $\mathbf{M}^n = 3^n\,\mathbf{U}\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}\mathbf{U}^{-1}$. However, a very small number of candidates are to be highly commended for the following insightful, approach: if n is odd, then $n-1$ is even, so that $\mathbf{M}^n = \mathbf{M}^{n-1}\,\mathbf{M} = (3^{n-1}\,\mathbf{I})\,(\mathbf{M})$ using the result of part (b)(i) $= 3^{n-1}\,\mathbf{M}$, as required.

Question 8

Most candidates made a good attempt at the first two parts and only a few got really 'bogged down' in part (c). It was necessary to spotting that $\det(\mathbf{MN}) = \det(\mathbf{M})\det(\mathbf{N})$, and these final two marks of the paper were nicely discriminating of the more able candidates' flexibility. Quite a few other candidates managed to see what was going on but didn't quite realise how to explain why the result arose or to identify correctly the x, y and z referred to.

Mark Ranges and Award of Grades

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