General Certificate of Education

Mathematics 6360

MFP4 Further Pure 4

Report on the Examination

2010 examination – June series

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General

There are now well over 1000 candidates sitting this paper in the summer session and, having run since June 2005, it is clear that the standard of the examination for this module is well-known. Several of the topics which had previously been found too demanding for many candidates now seem to be anticipated with obvious familiarity, and well-presented answers are much more commonly received.

Being the first time that this module's paper has appeared in a question paper/answer booklet format seemed to present no problem at all, and it even seemed to help candidates that answers were required in specific places in the booklet: there were very few extra insert-pages to be found and (mercifully) no instances of repeat attempts at various questions appearing in several places throughout a script. I am fairly certain that all candidates had the time to attempt all questions within their scope. In general it was only Question 8 that was (occasionally) left unattempted and this seemed to be due to uncertainty as to how to begin it rather than to a lack of time.

The greatest difficulties on the paper were to be found in those parts of questions where explanation or justification was required, and this was the only disappointing aspect of the candidature's performance. Overall, these explanations and/or justifications were poorly attempted, if at all. Most disappointing of all was the fact that so few seemed to realise that a justification was even expected.

Question 1

This was generally done very well. The only common mistake arose when candidates quoted the area formula for a triangle as $\frac{1}{2}|\mathbf{a} \times \mathbf{b}|$ but then thought that $\mathbf{a}$ and $\mathbf{b}$ were $\mathbf{p}$ and $\mathbf{q}$ (for instance) rather than $\overrightarrow{PQ}$ and $\overrightarrow{PR}$ (say).

Question 2

This was another straightforward question and was usually well-received and successfully attempted. In part (b), candidates seemed evenly split between those who recognised that $\mathbf{B}^{\mathrm{T}}\mathbf{A}^{\mathrm{T}} = (\mathbf{AB})^{\mathrm{T}}$ and those who simply worked out $\mathbf{B}^{\mathrm{T}}\mathbf{A}^{\mathrm{T}}$ directly. However, the very last mark on the question was often not gained, as many failed to show *visibly* that $x = \frac{1}{2}$ worked in **both** of the equations that arose when comparing elements of the two matrices.

Question 3

A similar fault was all too common here in part (a), even amongst those who presumably knew what they were doing. A lot of candidates correctly found $d = 10$ from the use of the vector $9\mathbf{i} - 8\mathbf{j} + 72\mathbf{k}$, yet still lost a mark by nowhere identifying this as the "$\mathbf{n}$" of the question … not even to the extent of writing down the answer in the form requested. This is just carelessness. Apart from a small minority who failed to identify $\mathbf{n}$ correctly, part (b) was found to be very straightforward indeed.

Question 4

This proved to be a good question for all but the weakest candidates, although it is still surprising how many mistakes are made over minus signs by further mathematicians, even when armed with a calculator. A little bit of care was needed in part(b) – almost invariably with the minus sign that accompanies the **j**-component – and it was hard to recover and answer part(c)(i) sensibly if part (b)'s answer was incorrect, as the t failed to cancel out. Part (c)(ii), where another explanation was required, received very poor answers indeed. There are so many valid possible "geometrical" conclusions that could be offered that it was very disappointing to see so few being offered. Most candidates opted to interpret the result as one

of linear independence, which isn't a geometrical statement at all. The key issue at stake here is that the answer is *always* 77, not just that it is 77 on some specific occasion, and the candidates' remarks were expected to reflect this.

Question 5

As usual, the general treatment of determinants using row/column operations was variably received: those who could, did … and generally scored at least six of the eight marks available. Those who were less clear about the topic generally scored nothing or, at best, scrabbled around for a couple of method marks somewhere. Fortunately, the proportion of candidates in the former camp continues to grow year-by-year.

A major bug-bear for the examiners is the decreasing inclination among candidates to give any hint as to what they are attempting to do with the rows and/or columns, leaving it to the markers to figure it out for themselves. In simple cases such as this, it isn't too much of a problem, but in more difficult cases examiners may be unable to award any marks unless there is a **clear method**.

Question 6

There were several easy marks to be had in this question, and the rest was helpfully sign-posted. Part (a)(i) was routine, as was part (a)(ii) … or it would have been had not, again, some sort of explanation been required for full marks. Approaches were evenly split between using the scalar-product and the vector-product. In the former case, a lot of candidates seemed to think they only needed to show that the line's direction vector was perpendicular to **one** vector parallel to the plane. In the second case, many candidates were content merely to find the vector product of the two vectors "in" (parallel to) the plane; others noted that it was a multiple of the d.v. of L without further comment. For the 3rd mark on this part of the question, we wanted an explanation as to *why* their scalar- or vector-product work established the given outcome – it is not enough for candidates merely to repeat the result that we gave them. *Given* results always require more of candidates by way of 'dotting the i's and crossing the t's'.

The more discerning teachers and students of MFP4 will understand why part (b) was set up as it was, since this is the only way to force candidates not just to resort to calculator-output generated answers. In part (c), remarkably few got past equating the equations of L and Π; the majority of candidates had no real idea what to do and so there were lots of answers seen in which the point of intersection was taken to be (–5, 8, –1).

Question 7

This question was handled very well indeed in its technical aspects – writing down eigenvalues and eigenvectors; finding a 2×2 inverse matrix; determining $\mathbf{M}$, and the accompanying matrix multiplications. So a lot of candidates scored lots of marks on this question. However, there were very few candidates indeed who managed to score more than 12 or 13, due to the explanations that were being looked for. At its simplest level, this began in part (a)(i), where candidates were required to write down "the eigenvalues and ***corresponding*** eigenvectors …" – in other words, to say which went with which. Examiners did not accept a fortuitously ordered separate pair of each (with a 50-50 chance of a correct pairing). In part (a)(ii), we also wanted to know **why** they had chosen one of the two possible lines as a line of invariant points (as opposed to just an invariant line).

Part (c) had been designed to require thought of the candidates, so the difficulties that arose here were not unexpected. There were two marks for explaining why the given expression was divisible by 13. The first was awarded to anyone who noted that the 1-1 element of $\mathbf{M}^n$ is an integer; the second, subtler, one was for the explanation of why it had to be an integer. Disappointingly few candidates got both marks.

Question 8

This question was not a success for most candidates. There were a lot of blanks drawn amongst candidates, and a lot more "solutions" which consisted of little more than "hopeful manipulation" of numbers. It appeared that a large number of candidates had simply stumbled on the determinant of 576 and then pointed out that k must be its square root. Many candidates took the opportunity to play around with the (given) 24 in all sorts of ways, some of which only fortuitously resembled correct working. Full or coherent explanations were in very short supply.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the **Results statistics** page of the AQA Website.