Version : 1.0 0608

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MFP4 Further Pure 4

Report on the Examination

2008 examination - June series

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Set and published by the Assessment and Qualifications Alliance.

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General
The great majority of candidates found this paper to be accessible with very few appearing to run out of time.

Question 1
This was a routine, straightforward question. A few candidates had difficulty turning a cartesian line equation into an eigenvector, eg $3x = 4y$ became the vector $\begin{bmatrix} 3 \\ 4 \end{bmatrix}$ rather than $\begin{bmatrix} 4 \\ 3 \end{bmatrix}$.

Question 2
This was another routine, straightforward question. Most candidates realised that the answers required in parts (b) and (c) came from those found in part (a). Others started again, working out, for instance, that $\mathbf{c} = -2(\mathbf{a} \times \mathbf{b})$ in order to find the value of t required in part (c).

Question 3
Almost all candidates did very well at finding the inverse matrix using the 'transposed matrix of co-factors' approach, and only a small proportion forgot the alternating signs and/or the transposition.

Question 4
This proved to be another accessible question, with the question's structuring helping candidates. Only a few opted to start again for part (b)(iii), for instance.

Question 5
Most difficulties with this question arose in part (a), where candidates had to consider the meaning and relevance of the information given to them in the question. The most commonly lost mark was in the widespread failure to point out that the line of invariant points was flagged up by the fact that the eigenvalue corresponding to the x-axis was 1. In general, most other marks lost on this question arose as a result of minor slips and oversights in the working. A few candidates didn't seem to know how to find $\mathbf{M}^n$.

Question 6
Despite a pleasing array of higher-powered techniques on display in solutions here, the low-tech method of first reducing the 3×3 system to a 2×2 system is by far the easiest approach, and the one most commonly used by candidates. However, although eliminating the y-variable first makes for the least demanding working, candidates' efforts were fairly evenly distributed amongst the three variables. Though this makes no difference in principle, the tendency for weaker candidates not to stop and think about their approach often led to unnecessarily tricky algebra later on in part (b), which then provided more opportunities for errors to occur in the solutions presented.

Question 7
Incorporating a 3×3 matrix inevitably leads to a higher degree of difficulty in finding the characteristic equation, and this frequently proved to be so for many candidates. Once again, however, it was the introductory remark required to explain the significance of a zero determinant that caused most difficulty. Surprisingly few candidates seemed entirely sure about it, and the most popular suggestion was that $\det \mathbf{W} = 0$ meant that volumes were unchanged. However, the majority of responses dwelt exclusively on the theme of areas, which would have been suitable only had $\mathbf{W}$ been a 2×2 matrix. A very few candidates produced a surprising answer, explaining that $\mathbf{W}$ was a "dimension-destroying (or crushing)" matrix. This gains no

credit, unless candidates then go on to explain that 3-d shapes become 2-d ones, or possibly even lines or points, at this stage. A lot of candidates wrote incoherent and meaningless statements: vague statements such as “it is co-planar” don’t carry much weight and certainly don’t get the marks.

Question 8

Because of its slightly unusual nature, this short question was put last, so that candidates would not spend time they could better employ elsewhere in trying to figure out what to do with it. In the event, it proved far less of a problem than anticipated. The intention was that candidates would expand the determinant fully to gain the expression $x^3 + y^3 + z^3 - 3xyz$ and then use row/column operations to extract the factor of $(x + y + z)$. Most did indeed do so. The mark most commonly lost was the final one of tying the two ends together, which many failed to do, and examiners were quite strict in not giving full marks for solutions which never got round to joining up two otherwise disparate bits of working.

Mark Ranges and Award of Grades

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