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Mathematics MFP4

(Specification 6360)

Further Pure 4

Report on the Examination

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General

Almost 350 candidates sat this paper and the overall standard of the candidature was very disappointing; only 9 candidates scored over 90% of the total raw mark available, while around a quarter of all candidates failed to exceed a mark of 30. It was very clear from the start of the marking that a lot of candidates had been entered at a stage of their preparation which was far too early to afford them the opportunity to do well. Many candidates seemed to have studied few of the topics on the specification; many more had so little idea of what to do that they were unable to attempt more than the most straightforward, introductory bits of several of the questions, and even those who did have an idea of how to start seemed to lack the technical ability to do it correctly. There were an extraordinary number of instances when candidates mixed up scalar and vector products, equations of lines and planes etc. There were also many cases where candidates were clearly trying to apply an idea from one topic out of context in another, such as "putting $z = 0$" in order to get something simpler to work with in only two variables.

There was another equally sad aspect to the written performance of many of the otherwise seemingly promising candidates. There were far too many who seemed to be very much "on the ball" in 4 or 5 topic areas, producing excellent work on the corresponding questions, but who then found at least a couple of questions where either their understanding or exam-readiness was clearly not yet up-to-speed and, despite, some insightful efforts, they were just not ready for an examination covering the whole of the module's work. This led to a lot of marks in the mid-40s or early 50s from candidates who would seem to be aiming for A-grade marks when they are fully prepared.

Question 1

This was a straightforward starter to the paper, and was generally found to be so by candidates. However, almost half of all candidates failed to score all 4 marks, due largely to arithmetical slips and carelessness with signs. This was mostly due to unhelpfully lengthy work on row- and/or column-operations after the $(x + y + z)$ factor had been extracted, when the simplest approach was to just go ahead and expand the remaining determinant. This highlights the view that many of these candidates had had insufficient practice with handling determinants algebraically in order to arrive at the point when they might have a "feel" for what is a good approach to take at different stages. Moreover, even in this example, it was about 50-50 whether candidates added R_3 into R_2 or vice versa; the latter approach clearly producing a simpler determinant to continue to work with afterwards, if some thought had been given to it.

Question 2

This turned out to be much more troublesome for candidates than had been anticipated, with almost two-thirds of the candidature failing to score a single mark on the question, despite the injunction to consider the definitions of the two products. Even amongst those who did proceed as planned, a large number of them insisted on using modulus signs and/or a unit vector throughout, indicating a lack of grasp as to what should, and what should not, have been involved. Some of these misuses of both notation and understanding of vector and scalar matters were condoned.

Question 3

This was generally well done, with marks relatively high. It was surprising to find that those who failed to get any integer value for t generally didn't appear to go back and check their working. Weaker candidates often didn't seem to know how to go about establishing consistency.

Question 4

This was another popular question, in that responses were generally at least partially successful. Even so, around half of all candidates failed to realise that the "hence" in part (a)(ii) meant that they were supposed to work algebraically with the result of part (a)(i) rather than go through the lengthy approach of finding $\mathbf{X}^{-1}$ directly. About the same proportion incorrectly opted for $(\mathbf{XY})^{-1} = \mathbf{X}^{-1}\mathbf{Y}^{-1}$. In addition to all these errors, a lot of marks were lost due to carelessness; mistakes made in calculating $\mathbf{X}^2$ were often not corrected, even when the candidates clearly failed to arrive at a multiple of $\mathbf{I}$ in part (a)(i).

Then, despite being told that $\mathbf{X}^{-1}$ could be found by $\frac{1}{20}(\mathbf{X} - \mathbf{I})$ in part (b), many made a slip somewhere in the working, and the correct $(\mathbf{XY})^{-1}$ appeared far less often than should have been the case, given the information given in the question.

Question 5

Around a third of the candidature attempted little beyond part (a), which was very surprising.

Of the majority who did proceed well into the question, part(b) was usually done well, although there were many sign errors that arose in the vector product of the two normals. Another surprise was the lack of appreciation that there was a factor of 13 which could be ignored here.

Of those who realised in part(c) that they simply had to substitute part(b)'s answer into Π_3's equation, a slight majority had incorrect components to work with, and this made follow-through marking difficult.

In part(d), only a very few spotted that they could answer this without any need to rely on previous answers, as a plane equation in the form $\mathbf{r} = \mathbf{a} + \lambda\mathbf{d}_1 + \mu\,\mathbf{d}_2$ could be written straight down using the two normals given in the question. The most popular form was, of course, $\mathbf{r} \bullet \mathbf{n} = d$, although a lot of candidates opted for a line equation here instead.

Question 6

Around a quarter of all candidates made attempts only at part (a), for just the one mark, and around half the candidates failed to proceed beyond part (b). Even amongst these, there was a large number of candidates who apparently didn't know the difference between vector and cartesian equations, with many others not happy to work with the given normal vector.

Of that half of the candidature that did proceed beyond part (b), most of them decided that "a distance of 50 units" meant that λ was $\pm$ 50, rather than $\pm$ 2. They had failed to realise that they had just worked out that the direction vector $12\mathbf{i} + 15\mathbf{j} + 16\mathbf{k}$ was 25 units long. This was very disappointing.

Even in the final part of the question, despite being given the coordinates of P and Q and the information that the line PQ was the height of a right-angled triangle with base 100, only about five candidates (of 336) appreciated that they could work out the area of the triangle just as it was. Even more disappointing than this was that so few could employ alternative vector methods to get the correct answer, mostly due to not having had much success with parts (a) to (c).

Question 7

This question produced many more at least partially successful attempts. Nonetheless, sign errors and arithmetical slips abounded and there was, yet again, very little evidence of tracking back to check obviously incorrect working and answers. It was only a very small minority who appreciated that a repeated eigenvalue should lead to an invariant plane, which needs two representative eigenvectors.

Uncertainty in parts (b) and (c) often led to marks not exceeding 10 out of the 15 available, even amongst the attempts of the better candidates.

Question 8

In part(a), many candidates realised the significance of both the sign and magnitude of the determinant of the transformation matrix, although there are still far too many who try to describe area scale factors without using the key word "area".

In part(b), almost all attempts managed to find or verify the given value of *p*, but most who did go on to try and find a value for *q* as well simply did what amounted to the same working again. The more successful bids found the eigenvalues first and then deduced *p* and *q*.

Attempts at part(c)(i) fell almost equally into the three categories of correct, incorrect – usually a 45^{o} or 90^{o} rotation matrix – or nothing at all. In part(c)(ii), however, candidates' lack of exam-readiness was once again markedly to the fore. The order of the two matrices was the right way round only about 50% of the time. More significantly the great majority decided that the best way to find a matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ such that $\begin{bmatrix} 0.6 & 0.8 \\ 0.8 & -0.6 \end{bmatrix}\begin{bmatrix} a & b \\ c & d \end{bmatrix} = \begin{bmatrix} -3 & 8 \\ -1 & 3 \end{bmatrix}$ (either way round on the LHS) was to multiply out and solve four simultaneous equations in the four unknowns a, b, c, d rather than pre-mutliply by an inverse matrix. Needless to say, most such attempts went wrong somewhere with the accompanying arithmetic and/or algebra, often due to pre-multiplying on one side of the matrix equation whilst post-multiplying on the other. Even more disappointing was the almost total lack of success of those attempts which did try to employ the inverse of a reflection matrix – candidates should have realised that such a matrix is self-inverse. In describing the shear in detail few candidates were very clear as to what was wanted. Even amongst those who reached the end of the question still with the opportunity to offer an answer, most didn't. Rather bizarrely, many offerings from candidates who did state something opted for a shear either parallel to one of the coordinate axes or parallel to (their) $y = qx$, despite the rather obvious flagging of $y = \frac{1}{2}x$ at several stages of the question.

Mark Ranges and Award of Grades

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