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Further Pure 4

Report on the Examination

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General

Overall, there is little doubt that students will have found this paper very demanding indeed, and very high scores (those significantly above 60) were rare.

Of the several factors in this widespread difficulty experienced by students, the most significant lay in the relatively lengthy and unstructured Q8(c). Assessment Objective 2 in the specification states that students are expected to be able to '*construct rigorous mathematical arguments and proofs through use of precise statements, logical deduction and inference and by the manipulation of mathematical expressions, including the construction of extended arguments for handling substantial problems presented in unstructured form,*' and Q8(c) was indeed a substantial problem of this kind. Unfortunately, hardly any of the students managed to construct their own intelligible mathematical arguments, and the lack of precise statements and almost any kind of construction or logical deduction was painful to behold.

However, this was not the only factor contributing to the relatively low marks of this summer's entry. Disappointingly, there were many students who clearly had not studied all of the work on this module. Routine, technical tasks were generally managed admirably, but there were several instances on this paper when students were required to provide an explanation or a bit of reasoning, and responses were usually poor or non-existent at these points. Additionally, many students did not know about direction cosines, or how to manipulate determinants, how to describe a shear and, most surprisingly, what a transpose matrix was.

Question 1

This was a popular and well-received starter question with most students scoring all 3 of the marks. The overwhelming majority went for the 3×3 determinant immediately, with just a small number opting instead for a staged approach of a vector product followed by a scalar one. This two-step approach, however, offered greater opportunity for students to make numerical or sign errors, an opportunity which was duly taken in many cases.

Question 2

Almost all students realised that $(4\mathbf{i} + 7\mathbf{j} - 4\mathbf{k})$ was the required direction vector, but a few were drawn to $(3\mathbf{i} - 2\mathbf{j} + 6\mathbf{k})$, probably by its better known integer magnitude of 7. The descriptions of direction cosines in part (b) were frequently vague or just incorrect: somewhere between a third and a half of all students must have stated that they were the actual angles between the line and the respective coordinate axes.

Question 3

The algebraic manipulation of determinants has always been found tricky by at least half of all students in each MFP4 paper set thus far, and this trend continued this summer also. Part of the difficulty here is in getting students not to expand prematurely; some students just cannot seem to resist doing so immediately, and many others expanded immediately after completing part (a), usually correctly. Giving them one factor, and requiring that they show it is a factor, not only gives them a bit of a start but forces them to do the manipulation. It was disappointing to see how many students, having successfully managed the first factor, lacked the confidence to repeat the process with their own choice of a second. Leaving the expansion until the last possible moment is the only way, for many, to get the complete factorisation correct.

Question 4

Part (a) was a routine and straightforward demand, as was part (b)(i), and most students gained these five marks. Solving the given system of equations was found to be less straightforward, although some students were able to use their calculators to reach an answer with relative ease.

As commented on in previous reports, students are reluctant to draw a quick, simple diagram that could direct their thoughts to what is required. Despite the fact that the whole thrust of the question had led to part (b)(iii), surprisingly few students really seemed to know what they were finding here, even when they had correctly completed all the preceding parts of the question.

Question 5

This was another popular and successful question in its earlier stages, and lots of students gained at least five of the first six marks. The one that was usually lost was the final mark, where all that was required was that they note that the relevant eigenvalue was 1 — explanations that attempted to describe this in prose were almost invariably both unnecessarily lengthy and technically incorrect in some important way. Most students made a stab at part (a)(iii), although few really knew how to demonstrate that the image of the point $\left(x,\ \frac{4}{3}x+c\right)$, namely $\left(x+9c,\ \frac{4}{3}x+13c\right)$, also lay on the line $y=\frac{4}{3}x+c$, despite the simple algebra involved: $\left(x+9c,\ \frac{4}{3}x+13c\right) = \left(x+9c,\ \frac{4}{3}[x+9c]+c\right)$ would have sufficed.

Even stranger still were the descriptions of the transformations required in parts (b) and (c). Despite being told explicitly that the first one was a shear, lots of students felt at liberty to pick another type of transformation to describe at this point. As for the second one, descriptions were equally bizarre and appeared to involve an element of guesswork. Practically no-one seemed to even consider that it was just the reverse of the first one — perhaps they could not believe it would be anything quite so straightforward. Of those who did understand that the question involved shears, nearly all either thought that the shears were parallel to an axis or that they were in perpendicular directions.

Question 6

Responses to this question were usually much more confident and, apart from the usual batch of numerical and/or sign slips, decently correct. Finding points and directions proved to be much more what students were expecting.

Question 7

Apart from the few who did not seem to know what a transpose matrix was, this was a popular and high-scoring question, even for those with relatively low scores on the paper as a whole. The only really disturbing aspect of the work on display was that in part (b)(ii) so few students seemed to have any idea how to go about finding a linear factor of a fairly simple cubic and then factorising to find the accompanying quadratic factor, which is C1 work. Most students who gained the answer $k = -3$ appeared to get it from a calculator, and very few indeed could use it to find the required quadratic factor; fewer still were able to reason convincingly that this quadratic factor had no real roots, which again is C1 work.

In the final part of the question, many students failed to realise that k was now being replaced in the given matrix $\mathbf{A}$ by $k - 7$, so that all they had to do was to add 7 to their previous value of k for two straightforward marks. Almost all students who correctly found the answer for this new k did so by going back, working out a cubic characteristic equation (with some large numbers for coefficients), and using a calculator to solve it for them. This was, somewhat reluctantly, awarded the marks if the answer was correct. Most of those students who did not get the correct answer also used this method, but any incorrect working prevented their calculator helping them out and so they gained no marks.

Question 8

As already mentioned in the introduction, this question proved to be very demanding and frequently candidates offered no attempt. Even though the three marks available in parts (a) and (b) were relatively straightforward, hardly any students managed to acquire all of them. This was because in part (b) almost all students undertook the expected method, gaining a zero scalar product, but then failed to consider that some explanation would be required as to why a successful perpendicularity test established parallelism.

Students arguably could be criticised for spurning some relatively straightforward marks earlier on in this paper, but not in the last part of this final question: it was always intended to discriminate and to stretch the most able. Most students did not know where to begin and so made no attempt. Most of the rest presented almost unintelligible amounts of any vector method they could think of at the problem, almost invariably without any explanation or structure to their working. As a result, there were three or four marks which we were prepared to give for useful introductory generalised points, vectors or distances, but hardly anyone could manage even these. It did not help when many, of the few who did try to do something here, thought that equal distances PQ and PR meant equal vectors $\overrightarrow{PQ}$ and $\overrightarrow{PR}$.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results statistics page of the AQA Website. UMS conversion calculator www.aqa.org.uk/umsconversion