A-LEVEL
MATHEMATICS

MFP4 – Further Pure 4
Report on the Examination

6360
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General

Overall the paper had a good mix of questions, allowing students to clearly show their ability at the subject. Stronger candidates were given questions that allowed them to demonstrate their ability, whilst weaker candidates had questions that allowed them to demonstrate key skills in topics such as cross products, factorising determinates, eigenvectors and inverting 3x3 matrices.

However, there was a surprisingly high level of numerical errors. For example, calculating the vector product often led to numerical errors.

Sensible methods received marks more quickly than simply crunching through reams of algebra.

Question 1

(a) Most candidates answered this question successfully, with an even split between those who expanded the full determinant $\begin{vmatrix} 1 & 3 & a \\ 2 & -4 & 7 \\ 2 & 2 & -2 \end{vmatrix}$ and those who worked out $\mathbf{u} \times \mathbf{v} = \begin{bmatrix} 12 \\ 4 \\ -10 \end{bmatrix}$ before finding the scalar product with $\begin{bmatrix} a \\ 7 \\ -2 \end{bmatrix}$.

(b) (i) This question was an easy continuation of part **(a)** with virtually all candidates gaining this mark.

(b) (ii) Many candidates got full marks here, with some losing the final mark either by forgetting to write the final linear combination of $\mathbf{v}$ and $\mathbf{w}$ or using their coefficient variable as the vector. However, a number of candidates got confused about what was being asked for and attempted to prove that $\mathbf{v}$ and $\mathbf{w}$ were in some way parallel or perpendicular to $\mathbf{u}$, earning them no marks.

Question 2

There was a wide spread of scores in this question.
A few candidates did not use vector product notation and so scored zero marks.
The anti-commutativity of the vector product caused problems for a large number of candidates. Some thought that $\mathbf{a} \times \mathbf{c} = \mathbf{c} \times \mathbf{a}$ and $\mathbf{a} \times \mathbf{b} = \mathbf{b} \times \mathbf{a}$, whilst others couldn't cope with the $\mathbf{b} \times \mathbf{c}$ and $\mathbf{c} \times \mathbf{b}$ terms (which cancelled) and either stopped halfway through the simplification or invented values for them.
The stronger candidates showed some very sound solutions.

Question 3

(a) Generally candidates coped well with this part, with scores commonly in the four to six mark range.
Some candidates added rows when they should have subtracted them and then forced the working by, for example, dropping the "$-2c$" term in the subsequent "$a+b-2c$" element. This approach did not score any marks.
Only a few candidates tried to expand the whole determinant and then factorise the resultant algebraic expression. This method gained no marks until the final, fully factorised form.
(b) This was done well with most candidates obtaining at least the first two follow through marks but full marks were only awarded to those who got part **(a)** fully correct. There was a surprisingly large number of candidates who put "$3+2=6$".
The alternative method of expanding the determinant again was generally used by candidates who had gone wrong in **(a)**.

Question 4

(a) This was generally done extremely well with most candidates picking up full marks.

(b) This part was meant to be a very straight forward comparison.
However, many candidates tried multiplying out $\mathbf{D} = \mathbf{U}^{-1}\mathbf{MU}$ or $\mathbf{UD} = \mathbf{MU}$. This led to pages of working that more often than not led to no marks as the candidate got bogged down in the algebra and stopped before the first mark could be awarded.

Question 5

(a) This is not a geometrical system. It is an algebraic set of equations. Marks were not given in this part for making geometrical observations. Part **(a)** splits down into two parts. First showing consistency, then finding a set of solutions for x, y & z in which a parameter is needed. Only the strongest candidates scored full marks in this part.

(b) A straight forward geometrical interpretation of **(a)**. However, no credit was given for guessing the answer.

Question 6

(a) Many candidates tackled this well, though there were a number of numerical errors in calculating the cross product, $\begin{bmatrix}-2\\10\\-2\end{bmatrix}$ was a common incorrect answer. Some candidates forgot to calculate the value of the cross product or say that it was $\neq\begin{bmatrix}0\\0\\0\end{bmatrix}$, this stopped them from gaining the mark.

(b) Those candidates who got **(a)** correct usually scored full marks here. Most marks lost were due to candidates getting confused as to where the directional vectors of a plane come from, or from miscalculation of the cross product.

(c) This part of the question was generally beyond all but the strongest candidates. A common incorrect attempt was to try to extend the vector DA through the plane.

Question 7

(a) Some weaker candidates got confused here, but most candidates answered this part well.

(b) (i) This part could be done very quickly using matrix algebra. However, a large number of candidates chose to proceed via the alternative algebraic route. This was much more time consuming, with more possibilities of making errors.

(b) (ii) Marks were only given here if the matrix in **(b) (i)** was correct. “Rotation” was a commonly guessed answer.

Question 8

This question was a good source of marks for candidates.

(a) This part was well done. Finding the inverse of 3x3 matrices is a good place to score marks. Candidates have obviously been well drilled in this skill.

(b) Nearly all candidates realised that they needed to multiply “6 “ by $\left|\mathbf{M}^{-1}\right|$. Many candidates tried to get $\left|\mathbf{M}^{-1}\right|$ from the matrix of $\mathbf{M}^{-1}$. It was much simpler (and more successful) to use $\left|\mathbf{M}^{-1}\right| = \dfrac{\mathbf{1}}{|\mathbf{M}|}$.

(c) In this part you cannot use $\mathbf{M}^{-1}$, as its singular for $k = 5$. Two marks was a very common score with candidates having difficulty dealing with x, y, z & x', y', z' and putting it all together.

(d) This part was more challenging, involving the use of $x = x'$, $y = y'$, $z = z'$ and generating the Cartesian equation of a line (not plane). Even so three to five marks were very commonly scored.

Mark Ranges and Award of Grades

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

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.

UMS conversion calculator