Examiners' Report/
Principal Examiner Feedback

Summer 2013

GCE Further Pure Mathematics FP3 (6669)
Paper 01

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Introduction

This paper proved accessible to the candidates. The questions differentiated well, with most giving rise to a good spread of marks. All questions contained marks available to the E grade candidate and there seemed to be sufficient material to challenge the A grade candidates also. The modal mark was full marks for all the questions except questions 7 and 8. Question 8 gave the greatest distribution of marks with very few candidates able to give the equation of the line in part (c) in the required form.

Generally the standard of presentation was good.

Report on Individual Questions

Question 1

The majority of candidates scored full marks on this question. Most could write down the equations for the foci and the eccentricity although a significant number used the eccentricity for the ellipse. The only other errors were mistakes with algebra and leaving the answer to part (a) as ±12.

Question 2

This question was generally well answered and most candidates used the arsinh form rather than the logarithmic form for part (a). Not surprisingly, a significant number of candidates missed out the coefficient of $\frac{1}{2}$ and this mistake then caused the loss of a second mark in part (b). A small number of candidates chose to integrate by substitution. In part (b) the limits were dealt with appropriately and logarithms were combined. Most candidates could obtain an answer in the required form.****
The very neatest solutions used:

$$\int_{-3}^{3} \frac{1}{\sqrt{4x^2+9}}dx = \frac{1}{2}\text{arsinh}(2) - \frac{1}{2}\text{arsinh}(-2) = \text{arsinh}(2) = \ln(2+\sqrt{5})$$

implicitly using the fact that $\text{arsinh}(x)$ is an odd function. This circumvented any need for rationalisation.

Question 3

Almost all candidates differentiated the parametric forms correctly and also substituted into a correct formula for the surface area. A significant number of candidates were then unable to make further progress as they struggled to remove the square root. Those who did manage to make progress to achieve $\sinh\theta\cosh^2\theta$ sometimes failed to spot that the reverse of the chain rule was needed. Some did however go on to successfully use hyperbolic identities to achieve an expression they could integrate. Although such methods were circuitous, they were sometimes impressively accurate.

Question 4

This was a good source of marks for many candidates with approximately 70% scoring full marks. The differentiation was usually very sound and the loss of marks usually resulted from slips when solving their equation in x and/or slips when substituting into the logarithmic form of arcosh to find the y-coordinate.

Question 5

For those candidates who knew the properties of eigenvalues and eigenvectors, the 8 marks in part (a) were readily available. A significant number of mistakenly thought that a matrix **M** with eigenvalue $\boldsymbol{x}$, always meant $\mathbf{M}\boldsymbol{x} = \boldsymbol{x}$ and used this for both eigenvectors. Also some candidates tried to establish the characteristic equation in a, b and c but obviously made little progress. Some also used a generalised eigenvector rather than the ones given and usually made equally little progress.

In part (b) the determinant was almost always correct although there were some surprising sign errors. For the inverse many could make a correct first step (usually a matrix of minors) and could go on to obtain the inverse with just the occasional slip. There were some candidates who attempted the write down the inverse in one step. With errors in their inverse in these cases it was difficult to identify a convincing method.

Question 6

Part (a) caused problems for many candidates and the majority were unable to see a way of making an appropriate start at achieving the given reduction formula. Many chose $\sqrt{(16 - x^2)}$ as dv/dx and made flawed attempts at integration.

Part (b) was met with more success irrespective of any progress in part (a) although there was some difficulty in establishing the value of I_1.

Question 7

Candidates were largely successful with part (a) with this standard work. The majority chose to use the chain rule to establish the gradient but some candidates used implicit differentiation. The coordinates in (a) and (b) were often found correctly but many candidates lost a mark for having a triangle with a negative area as they did not notice that one of the intercepts was itself negative. Part (c) allowed some independent marks to be scored and many could establish the correct value for θ and corresponding coordinates of P that maximised the area of the triangle. Some chose to find the maximum area of the triangle rather than the coordinates of P.

Question 8

Part (a) was usually solved using the formula in the formula book. The formula was often applied correctly although the "+ d" was sometimes missing in the numerator. The other two methods seen were the parallel plane approach and using the intersection of a perpendicular line through the plane.

In part (b) many could identify that a cross product was needed to establish the normal to the second plane although the method for the vector product was sometimes unclear. Even with clear methods, there were often errors in finding the components of the normal vector. The use of the scalar product to then find the required angle was known by the majority of the candidates although the incorrect use of arcsine to then find the angle was a common error here. Most candidates knew how to deal with the obtuse angle when it was obtained from the scalar product.

In part (c), many of the candidates recognised the need to find both the direction of the line of intersection of the planes Π_1 and Π_2 and a point which lies on the line and hence on both of these planes. Greater success was achieved in finding the line's direction with candidates using, in roughly equal proportion, either a vector product of the two normal vectors or the cartesian equations of this line of intersection. However, in finding the coordinates of a point on the line, there were many errors in the algebraic processing of the cartesian equations of the planes, thus losing the associated accuracy marks. The required form of this line, namely **r** x **a** = **b**, was clearly unfamiliar to much of the cohort and only a very few of the candidates obtained the correct line equation in this form.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
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