# Examiners' Report

# Summer 2014

## Pearson Edexcel GCE in Further Pure Mathematics FP3 (6669/01)

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# Mathematics Unit Further Pure Mathematics FP3

## Specification 6669/01

### General Introduction

This paper proved a good test of students' knowledge and students' understanding of FP3 material. There were plenty of accessible marks available for all students.

## Report on Individual Questions

### Question 1

In Q01(a) the vast majority of the students correctly identified the direction vector of the line and thus confidently formed the vector equation of the line, usually in the form $\mathbf{r} = \mathbf{a} + \lambda\mathbf{b}$. In Q01(b), the substitution of the line, once expressed in parametric form, into the given equation of the plane and a solution determined for $\lambda$, giving the required point, was well known by many of the students and most scored full marks in this part. However, in Q01(c), a significant minority did not use this point to determine the perpendicular distance of $P$ from the plane as requested, with many resorting to using the result given in the formula book, which scored no marks.

### Question 2

In Q02(a) nearly all of the students correctly attempted one of the many ways to test for orthogonality with the use of $\mathbf{M}\mathbf{M}^{\mathrm{T}} \neq \mathbf{I}$ being the most popular method. It is important that in questions such as this, that the students make a conclusion based upon the test being used.
In Q02(b) the vast majority of the students correctly formed the characteristic equation and thus found the three corresponding eigenvalues of the matrix $\mathbf{M}$. Most of the students were then able to use the equation $\mathbf{M}\mathbf{v} = \mathbf{v}$ to set up equations in $x$, $y$ and $z$ and solve to find the required eigenvector. However, $x = 0$ was a very common incorrect solution for $x$ and students clearly need to be aware that any eigenvectors found must be non-zero. In Q02(d), the majority of students were able to convert the given line equation into parametric form and then pre-multiply by the matrix $\mathbf{M}$. However, a significant minority of the students assumed that the direction vector for the line had a zero $\mathbf{i}$ component and thus lost the two accuracy marks for this part of the question.

### Question 3

In Q03(a), the vast majority of the students recognised the need to express the quadratic expression in completed square form and then use a standard integral given in the formula book and there were many correct solutions seen here. In Q03(b) most of the students substituted the exponential definition of $\sinh x$ into the integrand and, on expansion, were able to complete the integration. Less success was achieved by those students who used integration by parts and with parts having to be used twice, very few students gained full marks using this particular method of integration.

## Question 4

In Q04(a), the majority of the students began with the right-hand side and used the exponential definition of $\tanh x$ and basic algebraic processing to successfully produce the left-hand side. The solution in which both sides of the given identity were processed to an equivalent form was occasionally seen and often produced full marks for this part. A significant minority used only hyperbolic identities rather than the requested exponential definitions to prove the identity and such a solution earned no marks. In Q04(b), a large number of students were achieving full marks. A number of the students, in wishing to use hyperbolic identities, initially squared a rearrangement of the given equation to obtain a quadratic equation in terms of either $\sinh x$, $\cosh x$ or $\tanh x$. However, the students using this method often went on to find values for $x$ without using any exponential functions and thus gained no marks.

## Question 5

The vast majority of the students identified the given function as being composite and applied the chain rule in determining $\frac{\mathrm{d}y}{\mathrm{d}x}$. Most of the students used the product rule to differentiate $\frac{x}{\sqrt{1+x^2}}$ and the algebraic processing of the terms involved within both this and the quotient rule, when used, was generally of a good standard. Nearly all of the students correctly differentiated $\operatorname{artanh} x$ but the final stages of the solution caused some problems and a number of errors were seen in processing the terms down to the printed result. There were a number of students who initially rearranged the given function to make $\tanh y$ the subject and then used implicit differentiation and achieved equal success with those students who used the chain rule.

## Question 6

In Q06(a), the majority of the students formed an equation of the chord, scoring the first three marks, but then found the algebra challenging, this was made more demanding by the use of the trigonometric factor formulae and demanding trigonometric identity work and the final mark in this part was thus very rarely gained. In Q06(b) most students correctly formed the coordinates of the mid-point although there were some who subtracted the coordinates or who forgot to divide by two. In Q06(c), the vast majority made very little or no progress at all and did not appreciate that the equation of the locus of the chord's mid-point needed to be found. Those that understood this and hence found $\frac{x}{y}$ or $\frac{y}{x}$, managed to make good progress with this part. However, it was relatively rare to see a completely correct solution to Q06(c).

## Question 7

In Q07(a) nearly all of the students found an expression for $\frac{dy}{dx}$, with most using implicit differentiation to do so, from which they obtained the printed result. Of those using this method, the most common error was to differentiate $r^2$ to get $2r$. In Q07(b), the vast majority of students were familiar with the formula for finding the area of a surface of revolution, as given in the formula book. However, there were a number of errors made with each of the substitution for the function $y$, the limits of the integration and the actual integration itself. A significant number of students incorrectly used limits of 0 and 2r and integrated *kpr* to give $\frac{k\pi r^2}{2}$. In Q07(c) the relevance of the circle C was recognised by some students who could then write down the required arc length. The majority of the students, however, used both the answer to Q07(a) and the formula for arc length given in the formula book to attempt the arc length, with varying degrees of success.

## Question 8

In Q08(a) the majority of the students used, with much success, the cross product of two sides of the triangle $ABC$ to find its area although a significant minority incorrectly used two of the given vectors **a**, **b** and **c** and thus incorrectly used two sides of the triangle $OAB$, $OAC$ or $OBC$. In Q08(b) a great deal of success was achieved with the use of a 3x3 determinant often being used. In Q08(c) a number of students were able to make a correct deduction about the vectors **a**, **b** and **c** but many showed an inability to recognise the relevance of the result in Q08(b) and often wrote down contradictory statements about these vectors.

## Question 9

Many of the students found Q09(a) the most challenging part of the paper. For those that made an attempt, nearly all of them used integration by parts although there were a significant number of students who, in using this method, used incorrect expressions for $u$ and $\frac{dv}{dx}$ and hence made very little progress in their solution. For those students who initially made the correct choice of labels for $u$ and $\frac{dv}{dx}$, many then incorrectly went on to apply parts for a second time but more often than not, the solution was abandoned at this stage. Indeed, very few students achieved full marks for this part of the question. In Q09(b) the $I_{n+1}$ term in the given reduction formula caused confusion for some students, who are used to seeing an $I_n$ term on the left hand side and the incorrect substitution of $n = 2$ was a very common error. There were some students who, having substituted in the correct value of $n$, could not deal with the integration required to find $I_1$ and failed to recognise that it is given in the formula book.

**Grade Boundaries**

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

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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