Examiners' Report

Summer 2015

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

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General introduction

This paper proved a good test of students’ knowledge and students’ understanding of FP3 material. There were plenty of easily accessible marks available for students who were competent in topics such as hyperbolic functions, integration, vector methods and eigenvalues and eigenvectors. Therefore, a typical E grade student had enough opportunity to gain marks across the majority of questions. At the other end of the scale, there was sufficient material, particularly in later questions to stretch and challenge the most able students.

Report on Individual Questions

Question 1

The vast majority of students correctly used the identity $\cosh^2 x = 1 + \sinh^2 x$ to obtain a quadratic in sinh*x*. Most then used the logarithmic form of arsinh to obtain the final answers. Some students wrote sinh*x* in terms of exponentials and proceeded to solve the resulting quadratics in e^x and sometimes ended up with extra solutions that were not rejected. A significant number of students attempted to solve the given equation by expressing it in terms of exponentials. Such solutions usually stopped once a quartic in e^x was reached. Quite often, students who adopted this approach, realised that any progress would be difficult and so resorted to using the identity $\cosh^2 x = 1 + \sinh^2 x$.

Question 2

This was a good source of 5 marks for many students. There were some students who, although they started with a correct arc length formula, forgot to take the square root and so ended up integrating $\cosh^2 x$. The use of limits was generally sound and very few students failed to give their answer in terms of e. Some students started immediately with integrating cosh*x* and so were presumably find the area under the curve rather than the length. Although this gave the same answer, the benefit of doubt was not given.

Question 3

In part (a), the vast majority of students knew how to find the eigenvalues of the given matrix although there were a surprising number of errors when forming the characteristic equation. Sign errors were seen, together with a missing "-1" from the first term, if the first row of $\mathbf{A} - \lambda\mathbf{I}$ was used.

Students may have been surprised to find two irrational eigenvalues but persevered in part (b) and often found suitable eigenvectors although there were quite a few arithmetic slips and some students forgot to normalise or possibly did not know what normalised meant. A small minority of students struggled with the method for finding the eigenvectors and ended up with zero vectors.

It was clear that some students were unaware of the result in part (c) and although they sometimes knew what **P** was, proceeded to calculate **D** from $\mathbf{P}^{\mathrm{T}}\mathbf{AP}$ with mixed results. Those who did know **P** and **D** were, could often gain 2 follow through marks here despite earlier errors.

Question 4

In part (a), the majority of the students began by completing the square correctly and identifying the arcosh form, although a few gave $\text{arcosh}\left(\frac{x}{2}\right)$ rather than $\text{arcosh}\left(\frac{x+1}{2}\right)$. Some gave the logarithmic equivalent.

Part (b) was met with less success and it was surprisingly common to see $2\pi\int y^2\,\mathrm{d}x$ quoted for a volume of revolution and some students attempted to use the formula for surface area. Those who were integrating y^2 could often score the middle two marks by using the correct logarithmic form either from direct integration or by using a substitution or partial fractions.

Question 5

Students generally scored well on this question. In part (a) most could find a correct equation although some stopped having found the direction and some did not give the line as an equation as requested. Very few students gave the vector product form.
Most students knew the necessary form in part (b) although some did not understand what was meant by the cartesian form and offered the equation of a plane or simply left this part blank.

In part (c), most knew that a normal was required and used two vectors in the plane although some attempted to use two position vectors. Some students found a parametric form for the plane and then stopped.

The method in part (d) was well known and those students with an incorrect equation in part (c) could recover a mark here. The majority opted to calculate $\frac{p}{\hat{\mathbf{n}}}$ although some used a general perpendicular from O to the plane and then calculated its length.

Question 6

The mark in part (a) was almost always scored although $x = \pm 1$ was seen a few times.
Students were well rehearsed with the standard work in part (b) and errors were relatively rare.
In part (c), students made some progress although errors in establishing the coordinates of Q and R were quite common. Most knew the method to find a mid-point although the approach $\left(\frac{x_1 - x_2}{2}, \frac{y_1 - y_2}{2}\right)$ was seen occasionally. Some students wisely opted to work with the coordinates in exponential form and this simplified the work significantly.

Students generally struggled with part (d). It seemed that many were unaware of the right angle at O and tried various unsuccessful ways to find the area of *OQR*. It was common to see OP being used for the height of the triangle.

Question 7

Many correct proofs were seen in part (a). The most common approach was to write $\sin^n x$ as $\sin^{n-1}x\sin x$ and then attempt parts although a significant number of students differentiated $\sin^{n-1}x$ as $(n - 1)\sin^{n-2}x$ and potentially lost a significant number of subsequent marks. Some students wrote $\sin^n x$ as $\sin^{n-2}x\sin^2 x$ and then used $\sin^2 x = 1 - \cos^2 x$ and proceeded correctly. A significant minority of students incorrectly attempted parts using $\frac{\mathrm{d}v}{\mathrm{d}x} = 1$.

For those who attempted part (b), the first two marks were often scored with one application of the reduction formula using the given limits. To score any more marks, students were required to identify that I_1 would need to be evaluated at some stage. Those who did evaluate I_1 usually went on to score all 4 marks. There were some attempts at proof by induction for this part.

Students who had struggled with parts (a) and (b) sometimes picked up all three marks in part (c) once they realised that $I_5 - I_7$ was required. However, some struggled with the formula in (b) and calculations such as $I_5 = \frac{(5-1)(5-3).6.4.2}{5(5-2)(5-4).7.5.3}$ were sometimes seen.

Question 8

The majority of students could make some progress in part (a) although there were some arithmetic slips. Students very rarely used the wrong eccentricity formula but sometimes the foci were not given as coordinates.

Part (b) proved to be a challenge for many students although those who knew the focal property of an ellipse could achieve the result with minimal effort. Those who opted for an approach using Pythagoras had various degrees of success and often struggled with the algebra or were unable to deal with the square roots. Some chose to prove the result for a specific point such as (0, 1) and generally this was given no credit.

Part (c) proved to be very challenging with many students not knowing where to start or which strategy to adopt. Substitution of $y = mx + c$ into the ellipse proved to be a common approach but students then often tried to solve the resulting quadratic and made little progress. The other most common approach was to use the parametric form for two ends of a chord and then apply the factor formulae to find an equation for the locus of mid points. Those who adopted this approach often failed to use the factor formulae and could make little progress. In general, fully correct solutions to part (c) were very rare.

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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