Examiner's Report
Principal Examiner Feedback

Summer 2018

Pearson Edexcel GCE
In Further Pure Mathematics FP2 (6668/01)

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Introduction

This was a very straightforward paper which gave strong students few problems. The many good responses seen for question 8 suggested that time was not an issue.

There were many cases of notation errors such as missing equals signs and omission of dx (or appropriate variable) at the end of integrals. Brackets appear and disappear, only to re-appear again further on in the work. Students should remember that examiners mark what is written on the page. Missing brackets or poorly written final answers can result in the loss of the final mark(s), or sometimes more, of a question.

Question 1

This question was a good opening question for most students with the majority scoring full marks.

A few made errors in part (a), usually by having a sign error with one of the terms. In part (b) not all students showed sufficient terms to demonstrate the cancelling required. Occasional slips were made when forming the required fraction, including when attempting the common denominator. A few students used r instead of n in their working.

Part (c) saw more errors. Some used incorrect limits for the summation, typically $n = 30$ and $n = 15$ and others made errors when simplifying their fractions.

Question 2

There were a number of different approaches to this question about a complex plane transformation but there were two which were overwhelmingly popular amongst students.

The first used the information that z was real to write the complex number w in a form involving the real coordinate of z. This could then be split into real and imaginary parts with the required straight line coming from the coefficient of i.

The second did not use the information that z was real until later on. It began by taking the given fraction and rearranging it giving z as a function of w. The complex number w was replaced by u + iv and the resulting fraction was multiplied in the numerator and denominator by the complex conjugate of the denominator. The result then had its imaginary part set to zero to yield the required line.

When used, both of these methods were completed successfully by students with only the occasional sign error causing difficulties.

It was rare to see the other valid methods involving modulii, arguments or choosing points on the real axis. Students who chose any of these methods had a sound understanding of the principles involved and could achieve the required result.

Question 3

Students were generally very confident with the use of the addition formulae for sine and cosine needed for part (a) but many didn't explicitly state the values of sine and cosine in surd form and so lost all of the marks for this part. This showed a misunderstanding of the level of detail required in a formal proof where full evidence must be shown so there can be no doubt about the work not having been carried out on a calculator. Those that wrote all the surd values invariably got full marks.

Part (b) was done with widely varying degrees of confidence. Most could get a single root to the equation using a correct application of De Moivre’s Theorem. A large proportion managed to demonstrate the ability to calculate multiple roots using $2k\pi$ or rotation in an Argand diagram. The main loss of marks tended to be due to errors dealing with the surds in one or more of the roots. Generally there were errors with one or more of the roots which tended to be minor algebra or calculator slips rather than fundamental errors – most of these had written the roots correctly in $re^{i\theta}$ or $r(\cos\theta + i \sin\theta)$ form. It was worrying to see the number who had clearly spent an inordinate amount of time manipulating the roots and the associated surds. Relatively few realised that multiplying the first root by i three times generated the other 3 roots; in contrast those who did completed this question very quickly.

Question 4

Students would be well advised to use a sketch graph to help them sort out where the critical values lie on the graph. No solutions were seen where a graph with no supporting algebra was used to give the answers, indicating that students had understood the meaning of the question but had just used a graphical calculator. There were many completely correct solutions to this question.

The two separate cases resulting from $|x^2 - 2| = 4x$ were clearly set out by the majority of students and successfully solved in exact forms. Decimals were rarely seen; students seemed to have understood that such a question demands exact forms and not decimal approximations. The few errors that were seen were due to incorrect removal of the modulus signs on the left hand side rather than considering $+4x$ and $-4x$ on the right hand side.

Where a diagram would have helped would have been in the choice of the two regions required. There were some students who successfully used tables of values to aid them in their choice. Solutions were seen where all four critical values were used in various combinations of inequalities.

Question 5

This question was one of those that was better answered by the vast majority of students.

In part (a) the vast majority of students used the main method outlined on the mark scheme and were able to gain all 6 marks. A minority were not awarded the final M and A marks as they had insufficient working shown in their attempts to find a value for $\frac{\mathrm{d}y}{\mathrm{d}x}$ and subsequently insufficient working in their attempt to show that $\frac{\mathrm{d}^2y}{\mathrm{d}x^2} = \frac{3}{2}$.

A significant number of students divided the given expression by y, presumably in an attempt to avoid a product involving $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$. Only a small number of these gained all 6 marks with most of them making errors when differentiating the $3\frac{x}{y}\frac{\mathrm{d}y}{\mathrm{d}x}$ term.

Most students gained all 3 marks in part (b). However a minority lost the last mark as their final expression did not include "y =" or started "f(x) =" without an accompanying definition of $y = \mathrm{f}(x)$.

Question 6

This question was accessible to almost all the students and a majority were able to score most of the available marks. Most errors were caused by slips in arithmetic, algebra or differentiation, rather than a failure to use the correct process.

Most students were able to form and solve the auxiliary equation correctly and then correctly state the complementary function. Many students used their calculators to solve the equation. A significant minority lost the 6 and were therefore unable to gain the first two marks. There were some poor attempts at solving the equation, and it would be wise for students to check the solutions at this stage, as errors can result in the loss of several marks.

Most students used a particular integral of the correct form, though some had an x^3 term which they then found to be zero. This is acceptable, but others used a PI with only two terms, omitting the constant. Many numerical mistakes were made in calculating their coefficients. Usually the x coefficient caused the problem.

Most students knew they had to state their general solution starting with y = CF + PI

Most students attempted part (b) and were able to differentiate their general solution, although some differentiated a constant term to get a constant, ignoring the terms in x.

Some students took the wrong value for their $\frac{dy}{dx}$ and couldn't obtain correct values. Others obtained the correct simultaneous equations but were unable to solve them correctly. There were a few students who changed their values and signs from earlier correct work.

A minority of students did not attempt this question at all.

Question 7

There were numerous responses that were fully correct, but also plenty of opportunities for minor errors that could prove very costly.

Being a 'show that' question, detailed working was required to gain full marks and this was seen from most students. Differentiation was usually carried out correctly and way 1, 2 or 3 seemed the most popular approach. A small number of students were unsure which derivative was needed and usually only got one mark when they tried to differentiate $r\cos\theta$, making no further progress on the question. Most were able to solve the quadratic in terms of $\cos\theta$ but there were a few algebraic slips getting to the required answer. Few students could actually explain why one solution was rejected but some did this really nicely and a number of students went on to find θ though this was not required. A noticeable number of students did not attempt to find *OP*, possibly not realising that $OP = r$, even though $\cos\theta$ had been found.

This was more confidently attempted, though there was a noticeable number of students who, when expanding their brackets, forgot to double the middle term leading to a max of 3 marks out of 6. Other common errors included making a sign slip on their double angle formula, losing the 3 when substituting the double angle formula, trying to integrate their $\cos^2\theta$ term with the reverse chain rule or sometimes using the sine double angle formula rather than the cosine double angle formula. The majority of students were able to use a valid strategy for finding the area and used the correct limits.

Question 8

The majority of students were able to answer this question well, with many scoring full marks. The most common error was a loss of accuracy in part (a).

In part (a) the majority knew the method for substitution and could form an integral in terms of t only. A small number then failed to make significant progress. Errors in handling indices resulted in some students obtaining an incorrect power of t while other students failed to cancel the 2s and so obtained double the required integral.

Students who had obtained an integrand that could be integrated by parts generally started on this method. Those with an incorrect power of t sometimes made progress if the power was an integer or gave up after one application if the power was fractional. However, many lost accuracy when integrating, some losing a multiple of 2 when expanding brackets, others changing the index of t or making sign errors. A surprisingly large number of students made no attempt to reverse the substitution to obtain an answer in terms of x for part (a). Although this was done in part (b) the final mark in part (a) was already lost.

Students who obtained a correct exact differential equation in part (b) recognized that the answer to part (a) could be used without further working and most gave their final answer in the correct form. Most included a constant but some left it as $+C$ instead of $+Cx^{-4}$ in their final answer.

For students who achieved an answer to (b), substituting into their general solution did not prove a problem. Those with a correct answer to part (b) usually found the correct constant and went on to a correct particular solution. Those with an incorrect answer to part (b) would end up with an incorrect constant but could still access the final, follow through, mark. The most common error in part (c) was incorrect evaluation of e^{-x^2} at $x = 1$ as e^1 or even as just 1.

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