Examiners' Report/
Principal Examiner Feedback

Summer 2013

GCE Further Pure Mathematics FP2 (6668)
Paper 01R

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Further Pure Mathematics FP2 (6668R)

Introduction

This was a paper with some straightforward questions and some more challenging ones and thus every candidate was able to show what they had learnt. It was disappointing to see otherwise good candidates make basic errors when using mathematics learnt in earlier modules, for example when using trigonometric identities in question 8.

Sometimes the presentation of the work is poor, with equations straddling lines or very small handwriting with lots of scribbled out work. Poor presentation can lead to a candidate miscopying their own work or making other errors and so achieving a lower score. It is good practice to quote formulae such as the series expansion in question 4 before substitution. When an error is made on substitution the examiner needs to be sure that the correct formula is being used before the method mark can be awarded.

If a candidate runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

Report on Individual Questions

Question 1

This potentially straightforward question about a transformation in the complex plane caused many problems to candidates. Very few tried to start by using the information that points on the real axis in the *z* plane were the ones of interest in the question. Instead most candidates seemed to think that the way to begin was either to write *z* as $x + \mathrm{i}y$ and then collect real & imaginary parts and realise the denominator of the resulting fraction on the right hand side or to rearrange the equation to make *z* the subject, write $w = u + \mathrm{i}v$ and then again simplify and realise the right hand side. Having done this, there was confusion as to which part should be equal to 0 to obtain the equation of the required line.

It was disappointing to see candidates at this level accepting an equation which clearly represented a curve as the answer to a question asking for the equation of a line. Overall, this question showed that too many candidates are triggered into using standard methods without a clear understanding of how they work.

Question 2

This was a straightforward question in which many candidates scored full marks. Some candidates cross-multiplied and immediately lost the critical values 3 and -1 while others, having multiplied correctly by squares of the denominators failed to notice that the resulting expression had two common linear factors. Once all the brackets had been removed to obtain a quartic expression few could recover the four linear factors. Some students failed to recognise that their factorised quartic had a negative coefficient of x^4. This caused them to sketch an incorrect graph and choose corresponding incorrect inequalities.

Question 3

The splitting into partial fractions required in part (a) was achieved by almost all candidates. In part (b) the method of differences was clearly well understood and most candidates were able to show enough terms both at the beginning and the end of the summation to show the cancellation of terms convincingly. The terms in the summation were usually combined accurately and the final answer was achieved legitimately in the majority of solutions with very little evidence of inappropriate work to obtain the final printed answer. The amount of intermediate work shown to get the final answer was sufficient in most cases; many candidates did not combine the $\frac{1}{2}+\frac{1}{3}$ to a single fraction before including the algebraic fractions thereby doing more work than was necessary.

The final part had been tested before in previous papers and it was pleasing to note that candidates only rarely failed to do the sum of 100 terms minus the sum to 9 rather than 10 terms. There were occasional cases where the original fraction rather than the sum was used. Answers were given to the demanded three significant figures in nearly all cases.

Question 4

This question was well answered. Most errors were small accuracy issues. Some candidates did not read the question in part (a)and failed to rearrange their derivative into an expression for $\frac{d^3y}{dx^3}$. Rearranging the expression into $\frac{d^2y}{dx^2}$ and then differentiating seemed to cause more issues than differentiating then rearranging. It is worth reminding candidates that when solving a differential equation their final answer must be in terms of the correct variables, in this case, y as a function of x. Also, some candidates did not write down the general series expansion. A small slip when substituting their values results in the loss of the method mark as well as the accuracy mark in such cases.

Question 5

Most candidates recognised that this equation could be solved by the use of an integrating factor. The equation was already in the standard form and so the integrating factor was found correctly by the majority. It was rare to see the factor of 2 omitted or and the integral of $2\tan x$ to be incorrect and most got a simplified form of the integrating factor correct. The integral of $\sin 2x \sec^2 x$ was seen straightaway by those who rewrote $\sin 2x$; others took longer routes but did end up with an integrable form which, when integrated included the arbitrary constant. There were few solutions seen where this was omitted. The final part saw much correct work but candidates tended to fall at the last hurdle when trying – or in many cases omitting – to write the answer in the required form; *b* frequently was not an integer and so the final mark was lost.

Question 6

Another well answered question with most candidates knowing how to approach both proofs. Some candidates opted to find an expression for $\cos 5\theta$ then $\cos 3\theta$ by expanding $(\cos\theta + \mathrm{i}\sin\theta)^n$ and equating real parts, then substituted these into the right hand side of the proof. This was more complicated than expanding $\left(z + \frac{1}{z}\right)^n$ and many candidates simply found an expression for $\cos 5\theta$ and then were unable to complete the proof. In part (c) many candidates did not recognise the significance of $\cos^4\theta = -\frac{1}{8}$ and either failed to mention it at all or, in some cases, ignored the minus sign and solved $\cos^4\theta = \frac{1}{8}$ to obtain extra (incorrect) solutions.

Question 7

This question proved to be a valuable source of marks for many candidates with many fully correct solutions seen. In part (a) it was known that the particular integral and its derivatives had to be substituted into the given differential equation. The product rule was applied as necessary and the result $\lambda = 3$ obtained legitimately by most candidates. It is disappointing at this level to see some candidates accepting an answer where λ was a function of *t* or where the value $\lambda = 3$ was obtained by judiciously ignoring other terms in the equation involving *t* that had not cancelled out because of errors in differentiation. In part (b) the use of the auxiliary equation was well known and its solution of a repeated root leading to a complementary function in the form of $(A + Bt)\mathrm{e}^{3t}$ was also well known. Part (c) was completed correctly by most candidates, with only accuracy errors in the values of *A* and *B* being the bar to achieving a fully correct answer.

Question 8

It was surprising how few candidates realised that integrating from 0 to $\frac{\pi}{4}$ and multiplying by 4 was the easiest way to deal with part (a), but almost all candidates did manage to obtain the correct answer. Part (b) could be approached in a number of ways and most candidates knew to differentiate $r\sin\theta$. It was surprising that fewer students did not realise that by differentiating $r^2\sin^2\theta$ they could have simplified the algebra. The product and chain rules were generally used correctly but many candidates did not seem sufficiently confident with manipulating trigonometric expressions to be able to see their derivative through to a solution. Slips in accuracy led to equations becoming overcomplicated and the candidates were unable to recover. Poor handwriting and poor presentation did not help when trying to work out what some candidates were doing. Many candidates overcomplicated the final stage of this question by not realising that they could substitute $\theta = 0$ into r to find the width of the rectangle. Instead, time was wasted solving $\frac{\mathrm{d}}{\mathrm{d}\theta}(r\cos\theta) = 0$. It is worth reminding candidates that communicating their method is very important. Many candidates wrote minimal working and produced an answer for which, if incorrect, their working made it difficult to ascertain how the answer had been derived.

Grade Boundaries

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