Examiners' Report/
Principal Examiner Feedback

Summer 2012

GCE Further Pure Mathematics (6667)
Paper 01

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Summer 2012
Publications Code UA0322636

Introduction

The questions on the whole were well answered with many fully correct answers. Candidates found the paper very accessible and standard methods were well known and accurately applied.

The standard of presentation was generally good with solutions showing logical steps making the work easy to follow. The questions that proved most challenging were question 7 part (d), question 9 and question 10.

Report on individual questions

Question 1

This question was well done by many candidates although there were two particular places in the question where marks were lost. In part (a) virtually all successfully substituted $x = 4$ into f(x) but many failed show sufficient working to justify that f(4) = 0. Many incorrectly assumed that $3(4)^3 - 6(4)^2 - 7(4) - 4 = 0$ was enough. In part (b) many candidates successfully established the quadratic factor using either long division, comparing coefficients or inspection and went on to solve the resulting quadratic by using the formula or completing the square. A small number made an attempt at factorising.

There were a surprising number of cases where the final mark was lost when candidates failed to give the real root as well as the complex ones or confused solving with factorising. It was quite common to see $(x-4)\left(-\frac{1}{2}+\frac{1}{2}\mathrm{i}\right)\left(-\frac{1}{2}-\frac{1}{2}\mathrm{i}\right)$ as a conclusion.

Question 2

Part (a) was well answered with most candidates multiplying the matrices together correctly. Only a few candidates multiplied the matrices the wrong way round. In part (b) many could add the matrices correctly although a few candidates multiplied. The condition for there not being an inverse for **E** was well known and most attempted the determinant and set it to zero. The resulting equation in k was usually solved correctly although there were some basic algebraic errors.

Question 3

Many candidates gained full marks for this question. Errors usually resulted from incorrect differentiation on the second term of the expression. The most common error was to write

$\frac{3}{4\sqrt{x}}$ as $3 \times 4x^{-\frac{1}{2}}$ and hence obtain an incorrect derivative. Work was often clear and explicit with candidates showing both $\mathrm{f}(4)$ and $\mathrm{f}'(4)$ evaluated and substituted correctly into the Newton-Raphson formula. The minimum acceptable response required a correct derivative, a correct statement of the Newton-Raphson process and an answer to the correct accuracy. However, candidates are advised that in this type of question, full working should be shown. A small minority of candidates attempted interval bisection.

Question 4

In part (a) many candidates could start correctly by splitting the sum into three parts and substituted appropriate expressions for each sum. Those with any mistakes at this stage were unable to score any further marks. The subsequent algebra defeated some, and quite a few candidates could not establish the printed result. There were very few candidates who thought

$\sum_{r=1}^{n} 3 = 3.$ Part (b) was usually answered correctly by the majority of candidates but a significant number calculated $S_{30} - S_{16}$. A small minority substituted into the original cubic to find the sum.

Question 5

Parts (a) and (b) were usually very well answered although there was some confusion with coordinates at times with $x = 6$ being substituted into the equation for the parabola rather than $y = 6$. In part (c) the majority of candidates correctly identified the focus and followed this with correct work to find the equation of the line PS. Some candidates thought that a tangent was involved and proceeded to differentiate the equation for the parabola in order to establish the gradient, with no reference to the focus. It was disappointing to see a significant number of candidates failing to comply with the demand to have integer coefficients for the straight line.

Question 6

In part (a) candidates could usually evaluate both f(1) and f(2) correctly and also provided a suitable conclusion. Common errors occurred where candidates incorrectly worked in degrees or failed to provide an appropriate conclusion. In some cases candidates failed to give any conclusion at all.

The work in (b) was often sound although there were a significant number of cases where candidates used negative lengths in an otherwise sound method using similar triangles. The method of similar triangles was the most common although there were other methods that were more laboured such as finding the intersection with the *x*-axis of the line joining f(1) and f(2) which met with varying levels of success.

Question 7

In part (a) the majority of candidates could at least calculate the magnitude of the angle concerned but there were many cases where the sign was omitted. There were very few cases where candidates worked in degrees.
In attempting $z + z^2$ in part (b) most candidates made sound attempts at z^2 although there were some instances of poor algebra and sometimes insufficient work to show that $i^2 = -1$ but on the whole, the correct answer was seen very frequently.
In part (c) almost all candidates could substitute correctly for z and also the method for making the denominator real was well known. There were again some cases of poor algebra and/or an inability to deal with directed numbers correctly.
Part (c) proved to be a good discriminator and it was often the case that either the candidate knew what to do straight away or spent quite a lot of time making little progress.

Question 8

Part (a) was answered well by the majority of candidates. They were very few cases where the gradient was quoted rather than showing a full calculus method.
Part (b) was more challenging and a diagram was useful for some candidates. Those with correct coordinates for A and B could often proceed to a correct value for c although some left the answer as $\pm 3\sqrt{2}$. Some candidates did not appreciate what was required and failed to find the points A and B and simply used the x and y coordinates of P for the dimensions of the triangle.

Question 9

Part (a) caused few problems and any errors were largely arithmetical.
Part (b) was met with a great deal of success and the vast majority could obtain the correct value for *a*. There were a few cases where candidates took the more laborious route of working out $\mathbf{M}^{-1}$ and worked 'backwards'.

In part (c) the area of ORS was often calculated correctly and in part (d) the determinant property for areas was well known and candidates could score a follow through mark for an incorrect determinant and/or ORS area.

Part (e) was disappointing in that although many candidates appreciated that the transformation was a rotation of 90° anticlockwise, they failed to give the centre. A few candidates thought the transformation was a reflection.

Part (f) was a good test of whether a candidate knew in which order to write the matrices, given the combination of two transformations. In fact there were possibly equal numbers of candidates who started with **M** = **BA** as those with **M** = **AB**. The subsequent use of $\mathbf{A}^{-1}$ was often correctly applied. Many candidates chose to represents **B** as a general matrix $\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ and then calculate either **BA** or **AB** and compare the result with **M** to establish the values of a, b, c and d and hence the matrix **B**. This proved to be an efficient method given the nature of the matrix **A**. The incorrect matrix for **B** as $\begin{pmatrix} 2 & -5 \\ -3 & -4 \end{pmatrix}$ was common following an error with the order for matrix multiplication.

Question 10

This proved to be a good discriminator. Many candidates could make a start and proved the result was true for $n = 1$. There were then varying approaches at the induction with $f(k) - f(k+1)$ being the most popular but there were also other valid methods that met with varying degrees of success such as $\mathrm{f}(k) + \mathrm{f}(k+1)$ or attempts to deal with $\mathrm{f}(k+1)$ directly. Candidates who made it this far then often made some attempt to obtain an expression in terms of 2^{2k-1} and 3^{2k-1} but were then less successful in reaching an expression that was divisible by 5. The penultimate mark for all methods required completion to an expression for $\mathrm{f}(k+1)$ that was clearly shown to be divisible by 5. For the final mark the candidate needed to make a sensible conclusion, bringing the various parts of the proof together. An example of a minimum acceptable comment here, following completely correct work, would be 'if the result is true for $n = k$ then it has been shown to be true for $n = k + 1$ and as it was shown true for $n = 1$ then the result is true for all positive integers'.

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