Examiners' Report/
Principal Examiner Feedback

Summer 2012

GCE Core Mathematics C4 (6666)
Paper 01

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Introduction

This paper proved accessible and nearly all candidates were able to tackle all eight questions. However, there were parts of questions, for examples 5(c), 6(c) and 8(c), at which, in general, only strong candidates were able to make complete attempts and the paper discriminated well over the entire range of abilities.

The general standard of work seen was similar to that seen in recent years. The techniques of the calculus were well understood and, in general, the standard of presentation was satisfactory. Candidates need to take care over the details of elementary algebra and marks continue to be lost through the incorrect use, or sometimes complete absence, of brackets.

Most candidates used calculators appropriately, although, from time to time errors, such as the use of an incorrect angle mode, were seen. Problems continue to arise, however, when candidates give exact answers to questions, presumably derived from calculators with functions giving such answers, without any supporting working. The rubric on the front of the paper advises candidates that they "should show sufficient working to make your methods clear to the examiner".

Report on individual questions

Question 1

The majority of candidates gained full marks in part (a) and it was better done than similar questions in previous years. Most obtained the identity $1 = A(3x-1)^2 + Bx(3x-1) + Cx$ and found *A* and *C* by making an appropriate substitution. Finding *B* proved more difficult and the error $B = 0$ was not uncommon. In part (b)(i), most could gain the method mark, recognising that the integral of $\frac{1}{x}$ was $\ln x$, and those with incorrect non-zero values of *A*, *B* and *C* were able to benefit from follow through marks in this part. There were, however, many errors when finding $\int \frac{-3}{3x-1}\,\mathrm{d}x$ and $\int \frac{3}{(3x-1)^2}\,\mathrm{d}x$; $-3\ln(3x-1)$ and $3\ln(x-1)^2$, respectively, being common errors. The majority could start part b(ii) and, if they had correct values of A, B and C, then full marks for the question were common.

Question 2

This question was well done and more than half of the candidates gained full marks. The great majority of candidates gained full marks in parts (a) and (b). In part (c), most identified that they needed to find $\frac{\mathrm{d}A}{\mathrm{d}x}$ but some failed to realise that a cube has six faces and worked with $\frac{\mathrm{d}A}{\mathrm{d}x}=2x$ rather than $12x$. Not all realised that a chain rule was now needed and some simply calculated the value of $\frac{\mathrm{d}A}{\mathrm{d}x}$ at $x=8$. However, the majority were able to put together a meaningful chain rule and complete the question.

Question 3

A small number of candidates used the binomial expansion with index $\frac{1}{2}$ but the great majority used the correct index, $-\frac{1}{2}$, and were able to expand an expression of the form $(1-kx)^{-\frac{1}{2}}$ correctly to obtain at least three marks. Although many dealt with the 9 correctly, taking $9^{-\frac{1}{2}}$ outside a bracket, some did not combine it correctly with the 6, multiplying their binomial by 18 rather than 2. Full marks were common in part (a). In part (b), most realised that a change in signs was necessary but many changed the sign of the term in x^2 as well as the terms in x and x^3. Part (c) was less well done than part (b) and many multiplied all three of the terms in x, x^2 and x^3 by 2 instead of by 2, 4 and 8 respectively. Questions like parts (b) and (c) have rarely been set on these papers and it was clear that many candidates were not able to think their way into a solution that did not require a practised technique.

Question 4

This question was not well done and over one quarter of the candidates gained no marks on this question. In all of the other questions on the paper fewer than 8% of the candidates gained no marks. Many did not recognise that the question required a separation of the variables and they could make no progress.

The main error in separation was obtaining, through faulty algebra, $\int \frac{1}{y} \mathrm{d}y$ on one side of the equation. A quite unexpected error was to see those who had, correctly, obtained $\int y \, \mathrm{d}y$ integrate this to $\ln y$. The only explanation of this appears to be that many questions on this topic do result in logarithms and candidates were following an expected pattern rather than actually solving the question set. Those who could deal with the *y* side of the equation often had trouble with $\int \frac{1}{\cos^2 x} \mathrm{d}x$, not rewriting this as $\int \sec^2 x \, \mathrm{d}x$ and proceeding to $\tan x$. Many long and fruitless attempts were made using a double angle formula. Those who did integrate sometimes left it there, not realising that it was necessary to evaluate a constant of integration. About one third of candidates did obtain full marks.

Question 5

As has been noticed more than once in recent years, the topic of implicit differentiation is well understood and full marks in part (a) were very common. Mistakes mainly concerned the differentiation of $9x^2y$, involving a misinterpretation of the product rule.

Part (b) proved a test even for the most able. Most recognised that the numerator of their answer to (a) had to be equated to zero and obtained $xy = 3$ or an equivalent but then many just gave up then immediately. It was disappointing to see a significant minority of those who realised that they should solve the simultaneous equations $xy = 3$ and $16y^3 + 9x^2y - 54x = 0$, started by transforming $xy = 3$ to $y = 3x$. Those who did start correctly often had problems with the resulting algebra and had difficulty reaching the correct $x^4 = 16$ or $y^4 = \frac{81}{16}$. Those who got this far often failed to realise that these equations have two solutions. Those who had correct values for either x or y could complete quickly by substituting into $xy = 3$ but some made extra work for themselves by either starting all over again and finding the other variable independently or by substituting into $16y^3 + 9x^2y - 54x = 0$. The latter was particular unfortunate if x had been found first as this resulted in a cubic in y which is difficult to solve. This question was a very discriminating and it may be worth noting that the proportion of those who gained full marks on this question was slightly less than the proportion of those gaining the equivalent of a grade A on this paper.

Question 6

Nearly all candidates gained some marks in part (a) realising that they had to divide $\frac{\mathrm{d}y}{\mathrm{d}t}$ by $\frac{\mathrm{d}x}{\mathrm{d}t}$.

Most could differentiate $\sqrt{3}\sin 2t$ correctly, although occasionally dividing by 2, instead of multiplying, was seen. Differentiating $4\cos^2 t$ proved more difficult. Many had to use a double angle formula and this lead to many errors in signs and constants. $\frac{\mathrm{d}}{\mathrm{d}t}\left(4\cos^2 t\right) = k\sin^2 t$, where k might be $\pm 4, \pm 8$ or ± 2 was also frequently seen. Many who correctly obtained $\frac{\mathrm{d}y}{\mathrm{d}x} = -\frac{2}{\sqrt{3}}\tan 2t$ were unable to transform this correctly to the form specified in the question and, in this context, surd manipulation was a weak area. Nearly all knew how to solve part (b), a C1 topic, and, if they had a correct answer to (a), gained full marks here.

Part (c) proved demanding and only about 15% of the candidates were able to complete the question correctly. Many realised that they had to use a double angle formula and gained the first mark, either by writing $x = 2\sqrt{3}\sin t\cos t$ or $y = \cos 2t + 2$. Although other approaches are possible, the most commonly successful method was to use $\sin^2\theta + \cos^2\theta = 1$, where θ is either t or $2t$, to eliminate the parameter. There are many alternative forms of the answer to this question.

Some otherwise correct answers, for example, $x = \sqrt{3}\left(1 - \frac{\sqrt{y}}{2}\right)\sqrt{y}$, lost the final mark as the answer only gave half of the curve.

Question 7

Part (a) was accessible to most candidates. This was the first time in recent years that candidates had to produce their own table. This, in general, they did well although the number of decimal places recorded often seemed too few to be working towards a final accuracy of 2 decimal places. To obtain an answer of this accuracy, you should tabulate figures to at least 3 decimal places. Of course, the examiners have no means of knowing what figures the candidate has in their calculator and as long as there was some tabulation, or the exact expressions $\ln 2, \sqrt{2}\ln 4, \sqrt{3}\ln 6 \text{ and } 2\ln 8$ were given, and the working showed that the correct formula was known, then, if 7.49 was given as the answer, the candidate was given the benefit of the doubt. A few candidates confused the number of strips with the number of ordinates but these were fewer than in some recent examinations.

In part (b), most knew that they had to use integration by parts and most attempted this in the "right direction" attempting to integrate $x^{\frac{1}{2}}$, which was usually correct, and differentiate $\ln 2x$, for which the incorrect $\frac{1}{2x}$ was often seen. Many who reached the intermediate stage correctly had difficulty with $\int \frac{2}{3}x^{\frac{3}{2}}.\frac{1}{x}\mathrm{d}x$, failing to divide $x^{\frac{3}{2}}$ by x. Fully correct solutions to part (b) were not common.

If they had an answer to part (b) in the correct form, then most candidates showed that they could complete the question by using the limits correctly and then using the power rule for logs to obtain an answer in the form specified. There were many errors of detail in candidates' solutions to this question but more than 50% of candidates gained eight or more of the available eleven marks..

Question 8

In part (a), both marks were gained by nearly all candidates. Only a minority added the components or subtracted them the wrong way round. If $\overrightarrow{BA}$ was given instead of $\overrightarrow{AB}$, one mark was lost here but all other marks in the question could be gained. Again, in part (b), most candidates gained both marks but a substantial number of candidates failed to realise that the equation of a line must actually be an equation and, for example, omitted the "$\mathbf{r} =$" from $\mathbf{r} = \begin{pmatrix} 8 \\ 3 \\ 4 \end{pmatrix} + \lambda \begin{pmatrix} -2 \\ 1 \\ 1 \end{pmatrix}$.

Part (c) was very demanding and often proved to be an all or nothing affair. Correct methods were not often seen but, when they were, full marks were usually gained. Most knew that they should equate a scalar product to zero but the wrong vectors were often used. It would have helped candidates if they had drawn a diagram showing the points *O*, *A*, *B*, *C* and *P*. The scalar products $\overrightarrow{OP}.\overrightarrow{AB}$ or $\overrightarrow{OP}.\overrightarrow{OC}$ were often used instead of $\overrightarrow{CP}.\overrightarrow{AB}$. To make progress with this question it is necessary to use the correct scalar product to obtain an equation in a single parameter, not the three unknowns x, y and z. The most commonly seen successful method was to use the candidate's answer to (b) to obtain a vector expression for $\overrightarrow{CP}$ in terms of, say, λ. If the equation of the line is that given in the previous paragraph, this gives $\overrightarrow{CP} = \begin{pmatrix} 5-2\lambda \\ \lambda-9 \\ \lambda+1 \end{pmatrix}$. The scalar product of this vector with the answer to part (a) gives an equation for λ. The value of the parameter given by this equation can then be substituted into the answer to part (b) to complete the question. There are alternative approaches to this question using differentiation or using the cosine rule to find the ratio, for example, $AB : AP$ but these were very rarely seen.

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