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Principal Examiner Feedback

Summer 2013

GCE Core Mathematics C4 (6666)
Paper 01

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Introduction

This paper proved to be slightly more difficult than recent C4 papers, but there was still enough opportunity for grade E candidates to gain marks across many of the first 6 or 7 questions. At the other end of the scale, there were some testing questions involving binomial expansions, parametric equations and differential equations that allowed the paper to discriminate well across the higher ability levels.

Examiners were impressed with quality of candidates' presentation and how in many cases solutions were methodical and easy for examiners to follow.

The standard of algebra was impressive, although a number of candidates made basic sign or manipulation errors in questions 4(a), 5(c), 6(b), 6(c), 7(b) and 8(c). In summary, questions 1, 2, 3, 4(a), 5(a), 5(b) and 6 were a good source of marks for the average candidate, mainly testing standard ideas and techniques; and questions 4(b), 5(c), 6(d), 7 and 8 were discriminating at the higher grades. Question 8 proved to be the most challenging question on the paper, with only about 7% of the candidature able to gain all 12 marks.

Report on individual questions

Question 1

This question was generally well answered with about 74% of candidates gaining all 4 marks.

The majority of candidates were able to split up $\frac{5x+3}{(2x+1)(x+1)^2}$ in the correct form of $\frac{A}{(2x+1)}$ + $\frac{B}{(x+1)}$ $\frac{C}{(x+1)^2}$ although some missed the $(x + 1)$ factor to give the incorrect form of $\frac{A}{(2x+1)}$ + $\frac{B}{(x+1)^2}$. Many candidates were successful in either substituting values and/or equating coefficients in order to find their constants. A minority who unnecessarily formed three simultaneous equations by equating coefficients were less successful in finding all three constants correctly.

Question 2

This question was generally well answered with about 62% of candidates gaining at least 6 of the 7 marks available and about 27% of candidates gaining all 7 marks.

Most candidates were able to differentiate implicitly but a significant minority struggled to differentiate 3^{x-1} and a few candidates did not apply the product rule correctly on xy. At this point a minority of candidates substituted $x = 1$ and $y = 3$ in their differentiated equation, but the majority of candidates proceeded to find an expression for $\frac{dy}{dx}$ in terms of x and y, to give any equation of the form $\frac{dy}{dx} = \frac{y + 3^{x-1}\ln 3}{2y - x}$ before substituting in these values. Although the majority of candidates were able to write $\frac{dy}{dx}$ as $\frac{3 + \ln 3}{5}$, most of them did not show sufficient working (i.e. writing 3 as $\ln e^3$) in order to prove that this could be manipulated to give $\frac{1}{5}\ln(3e^3)$.

Question 3

This question was generally well answered with about 57% of candidates gaining at least 7 of the 8 marks available and about 46% of candidates gaining all 8 marks. About 10% of candidates, however, did not score on this question.

Most candidates followed the advice given in the question and used the substitution $u = 2 + \sqrt{(2x + 1)}$. Most differentiated this correctly to give either $\frac{du}{dx} = (2x+1)^{-\frac{1}{2}}$ or $\frac{dx}{du} = u - 2$ although a few differentiated incorrectly to give $\frac{du}{dx} = \frac{1}{2}(2x+1)^{-\frac{1}{2}}$. The majority were then able to apply the substitution and reach an integral of the form $k\int \frac{(u-2)}{u}\,du$. Whilst most candidates reaching this stage then correctly divided through by u and integrated term by term to reach an expression of the form $k(\ln u - u)$, a few resorted to integration by parts or partial fractions and were generally less successful. Most candidates applied changed limits of 5 and 3 correctly to their integrated function in u and a few converted back to a function in x and used limits of 4 and 0 correctly. Disappointingly a number of candidates did not express their answer in the form $A + 2\ln B$ and gave answers such as $2 - 2\ln\frac{5}{3}$ or $2 + \ln\frac{9}{25}$.

Question 4

This question was generally well answered with about 76% of candidates gaining at least 6 of the 9 marks available and about 17% of candidates gaining all 9 marks. Part (a) was accessible with most candidates scoring all 6 marks and part (b) was discriminating and challenged the more able candidates.

In part (a), most candidates manipulated $\sqrt[3]{(8-9x)}$ to give $2\left(1-\frac{9x}{8}\right)^{\frac{1}{3}}$, with the 2 outside the brackets sometimes written incorrectly as either 1 or $\frac{1}{2}$ and a few incorrectly used a power of $\frac{3}{2}$. Many candidates were able to use a correct method for expanding a binomial expression of the form $(1 + ax)^n$. A variety of incorrect values of a were seen, with the most common being $\frac{9}{8}$. Some candidates, having correctly expanded $\left(1-\frac{9x}{8}\right)^{\frac{1}{3}}$, forgot to multiply their expansion by 2. Sign errors, bracketing errors, and simplification errors were also seen in this part.

In part (b), the majority of candidates solved the equation $\sqrt[3]{(8-9x)} = \sqrt[3]{1700}$ to give an answer of $x = -788$. These candidates substituted this value of x into the answer they had found in part (a), even though the question states that the binomial expansion is only valid for $|x| < \frac{8}{9}$. Only a minority of candidates realised that they needed to simplify $\sqrt[3]{1700}$ to $10\sqrt[3]{7.1}$ before deducing that they needed to substitute $x = 0.1$ into their binomial expansion. Most of these candidates achieved the correct approximation of 19.2201, although a few forgot to multiply by 10 at the end and wrote 1.9220.

Question 5

This question was generally well answered although part (c) was found challenging by a number of candidates. About 56% of candidates gained at least 10 of the 12 marks available and about 23% of candidates gained all 12 marks.
In part (a), most candidates correctly computed 6.248 to 3 decimal places, but a few gave their answer to only 2 decimal places.

In applying the trapezium rule in part (b), a small minority of candidates multiplied $\frac{1}{2}$ by $\frac{8}{5}$ instead of $\frac{1}{2}$ by 2. Whilst the table of values clearly shows an interval width of 2, the application of a formula $h = \dfrac{b-a}{n}$ with $n = 5$ instead of $n = 4$ sometimes caused this error. Other errors included the occasional bracketing mistake, use of the t-value of 0 rather than the ordinate of 3, and the occasional calculation error following a correctly written expression.

In part (c), a significant minority were only able to integrate 3 to give $3t$ but struggled to apply the correct strategy to integrate $4te^{-\frac{1}{3}}$ with respect to t. On the other hand, some candidates applied integration by parts correctly to give $-12te^{-\frac{1}{3}} - 36e^{-\frac{1}{3}}$ but then omitted the integration of 3 to give $3t$. A common error was $e^{-\frac{1}{3}t}$ being integrated to give $-\frac{1}{3}e^{-\frac{1}{3}t}$. There were a number of able students who, having integrated correctly, could not simplify their answer to give the exact value of $60 - 132e^{-\frac{8}{3}}$.
Most candidates who answered parts (b) and (c) correctly were able to find the correct difference of 1.46 in part (d), although a few found the percentage error of the estimate. Some candidates who had not answered part (c) correctly applied numerical integration in their calculator to give 50.828... and so were able to find the correct answer to part (d).

Question 6

This was a well answered question on vectors with about 56% of candidates gaining at least 10 of the 12 marks available and about 23% of candidates gaining all 12 marks. Part (d) required the more able candidates to think for themselves.

In part (a), most candidates set the line l equal to the point A and equated the k components to find the value of λ. This was followed by equating the i components to find the correct value of a, although some candidates, however, incorrectly found $a = 3$ from $a + 6(4) = 21$. A small minority of candidates wrote down equations for the **i** and **k** components and solved these simultaneously to find a.

In part (b), almost all candidates found $\overrightarrow{AB}$ and many applied $\overrightarrow{AB} \cdot \begin{pmatrix} 6 \\ c \\ -1 \end{pmatrix} = 0$ in order to find the value of c and proceeded to find the value of b. Some candidates incorrectly applied $\begin{pmatrix} -3+6\lambda \\ b+c\lambda \\ 10-\lambda \end{pmatrix} \cdot \begin{pmatrix} 6 \\ c \\ -1 \end{pmatrix} = 0$ and thus made little progress. Some candidates incorrectly found $c = 4$ or 3 from a correct $24 + 3c - 12 = 0$ whilst others incorrectly found $b = -33$, 33 or 1 from a correct $b = (-4)(4) = -17$.
In part (c), most candidates were able to find the correct distance AB and few errors were seen.

In part (d), the majority of candidates were not able to use the information given earlier in the question and many of them left this part blank. The most common error of those who attempted this part was to write down B' as $-25\mathbf{i} + 14\mathbf{j} - 18\mathbf{k}$. Those candidates who decided to draw a diagram usually increased their chance of success. Most candidates who were successful at this part applied a vector approach as detailed in the mark scheme. Some candidates, by deducing that A was the midpoint of B and B' were able to write down $\frac{x+25}{2} = 21$, $\frac{y-14}{2} = -17$ and $\frac{z+18}{2} = 6$ in order to find the position vector of B'.

Question 7

This question was challenging and discriminated well between candidates of all abilities, with about 40% of candidates gaining at least 9 marks of the 12 marks available and about 8% gaining all 12 marks. A significant number of candidates scored full marks in part (c).

In part (a), the majority of candidates were able to apply the process of parametric differentiation followed by substitution of $t = \frac{\pi}{6}$ into their $\frac{dy}{dx}$. Some candidates could not differentiate $27\sec^3 t$ correctly whilst others did not achieve $\frac{1}{18}$ after substituting $t = \frac{\pi}{6}$ into a correct $\frac{dy}{dx}$.

In part (b), many candidates were able to use a correct trigonometric identity in order to eliminate t and achieve an equation in x and y. Whilst most candidates used $1 + \tan^2 t \equiv \sec^2 t$, some candidates were successful with using $\tan t \equiv \frac{\sin t}{\cos t}$ and $\sin^2 t + \cos^2 t \equiv 1$. Inevitably there was some fudging to arrive at the correct answer and some candidates wrote down and applied an incorrect identity. Some candidates did not attempt to find the values of a and b and those that did often gave incorrect values such as $a = 0$, $b = 27$ or b as infinity.

In part (c), the majority of candidates were able to apply volume formula $\pi\int y^2 \ dx$ on $y = (x^{\frac{2}{3}} - 9)^{\frac{1}{2}}$. A number of candidates, however, used incorrect formulae such as $2\pi\int y^2 \ dx$ or $\int y^2 \ dx$ or even $\int y \ dx$.

Most candidates where confident with integrating $x^{\frac{2}{3}} - 9$ although some applied incorrect x-limits of 0 and 27 or 0 and 125 to their integrated function. A significant minority did not use the hint in part (b) and attempted to find the volume by parametric integration. Whilst a number of them were able to write down $729\pi\int \tan^3 t\sec^3 t \ dt$, it was rare to see this integrated correctly.

Question 8

In general, this was the most poorly answered question on the paper with about 15% of candidates who failed to score and about 11% of candidates gaining 1 mark usually in part (a). This question discriminated well between candidates of higher abilities, with about 27% of candidates gaining at least 8 of the 12 marks available and only about 7% of candidates gaining all 12 marks. Many weaker candidates made little or no progress in part (b), maybe because of the generalised nature of the differential equation.

In part (a), a significant number of candidates were not clear or precise in their explanations. A number of them used the word "mass" and it was not clear whether they were referring to the mass of the unburned fuel or the mass of the waste products.
In part (b), those candidates who were able to separate the variables, were usually able to integrate both sides correctly, although a number of candidates integrated $\frac{1}{M-x}$ incorrectly to give ln (M – x). Many others substituted $t = 0$, $x = 0$ immediately after integration, to find their constant of integration as $-\ln M$ and most used a variety of correct methods to eliminate logarithms in order to find $x = M(1 - e^{-kt})$ (or equivalent). A significant number of candidates, however, correctly rearranged their integrated expression into the form $x = M - Ae^{-kt}$ before using $t = 0$, $x = 0$ to correctly find A. Common errors in this part included omitting the constant of integration or treating M as a variable. Also, a number of candidates struggled to remove logarithms correctly and gave an equation of the form $M - x = e^{-kt} + e^{c}$ which was then sometimes manipulated to $M - x = Ae^{-kt}$.

In part (c), some candidates were able to substitute $t = \ln 4,\ x = \frac{1}{2}M$ into one of their equations involving x and t, but only a minority were able to find a numeric value of k.

Only the most able candidates were able to find $k = \frac{1}{2}$ and substitute this into their equation together with $t = \ln 9$ to find $x = \frac{2}{3}M$.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
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