Examiners' Report/
Principal Examiner Feedback

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GCE Core Mathematics C4 (6666)
Paper 01

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Report on Individual Questions

Question 1

This question was generally well answered with about 70% of candidates obtaining all of the 5 marks available.

A minority of candidates were unable to carry out the first step of writing $(2 + 3x)^{-3}$ as $\frac{1}{8}\left(1+\frac{3x}{2}\right)^{-3}$, with the $\frac{1}{8}$ outside the brackets usually written incorrectly as either 2 or 1. 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 either 3, $\frac{2}{3}$ or 1. Some candidates, having correctly expanded $\left(1+\frac{3x}{2}\right)^{-3}$, forgot to multiply their expansion by $\frac{1}{8}$. Errors seen included sign errors, bracketing errors, missing factorials (for example, 2! or 3!) and simplification errors.

Question 2

Only about 45% of the candidates were able to gain all 7 marks in this question as it involved a challenging integration by parts, on account of the term $\frac{1}{x^3}$. This meant that candidates had to be especially careful when dealing with negative powers of x.

In Q2(a), the majority of candidates applied the integration by parts formula correctly in the right direction to gain 3 out of the 5 marks available. Many of them then proceeded to integrate an expression of the form $\frac{\mu}{x^3}$ to give an expression of the form $\frac{\beta}{x^2}$ although a minority gave an expression of the form $\frac{\beta}{x^4}$. A significant number of candidates failed to gain the final accuracy mark due to sign errors or errors with the constants α and β in $\frac{\alpha}{x^2}\ln x + \frac{\beta}{x^2} + c$. A minority of candidates applied the by parts formula in the 'wrong direction' and incorrectly stated that $\frac{dv}{dx} = \ln x$ implied $v = \frac{1}{x}$.

In Q2(b), most candidates gained the method mark for substitution of $x = 2$ and $x = 1$ into their answer in Q2(a) and subtracting the correct way round. The final mark was largely dependent upon their having obtained the correct answer in Q2(a).

Question 3

This was correctly answered by about 40% of the candidates.

A majority incorrectly expressed $\frac{9x^2 + 20x - 10}{(x + 2)(3x - 1)}$ as $\frac{2}{(x + 2)} - \frac{1}{(3x - 1)}$, having failed to realise that the algebraic fraction given in the question is improper, thereby losing 3 of the 4 marks available.

For those achieving the correct partial fractions, a process of long division was typically used to find the value of the constant term, and the resulting remainder, usually $5x - 4$, became the LHS of the subsequent identity. A minority of them, however, applied $9x^2 + 20x - 10 \equiv A(x+2)(3x-1) + B(3x-1) + C(x+2)$ in order to obtain the correct partial fractions.

Question 4

This question was answered well across all abilities. Whilst the majority of candidates were able to score full marks in Q4(a) and Q4(b), Q4(c) was found to be more challenging. Despite the challenging nature of Q4(c), it was encouraging to see a good number of clear, logical and accurate solutions.

In Q4(a), although most candidates correctly computed 1.0981, a significant number wrote 1.0980, suggesting that truncation rather than rounding was applied by some at this stage.

In applying the trapezium rule in Q4(b), a small minority of candidates multiplied $\frac{1}{2}$ by $\frac{3}{4}$ instead of $\frac{1}{2}$ by 1. Whilst the table of values shows clearly an interval width of 1, the application of a formula $h = \frac{b-a}{n}$ with $n = 4$ instead of $n = 3$ sometimes caused this error. Other errors included the occasional bracketing mistake and the occasional calculation error following a correctly written expression.

In Q4(c), candidates clearly knew that they needed to transform an integral in $\mathrm{f}(x)$ into an integral in $\mathrm{g}(u)$ and most began as expected by finding $\frac{\mathrm{d}u}{\mathrm{d}x}$. The omission of $\frac{\mathrm{d}x}{\mathrm{d}u}$ from the integral expression for the area resulted in a simpler function in u with a consequent loss of marks. Other errors on substitution were the use of $u^2 - 1$ instead of $(u-1)^2$ and multiplication by $\frac{\mathrm{d}u}{\mathrm{d}x}$ instead of by $\frac{\mathrm{d}x}{\mathrm{d}u}$. For those who did obtain an expression of the form $\frac{2(u-1)^3}{u}$, many expanded the cubic part, divided the result by u and integrated the result as expected, although sometimes making an error on expansion or forgetting to multiply by the 2. Some candidates, however, attempted integration by parts or integration without expansion on $\frac{(u-1)^3}{u}$ resulting in erroneous expressions such as $(u-1)^4 \ln u$ or $\frac{(u-1)^4}{4u}$. Despite previous errors, the majority of candidates were able to apply the changed limits of 3 and 2 appropriately to an ‘integrated’ function in *u*. A return to *x* limits would have been acceptable but was seldom seen and only occasionally *x* limits were used erroneously in a function in *u*.

Question 5

This question, and in particular the final Q5(d), proved challenging for a large number of candidates, with about 18% of the candidature scoring at least 12 of the 15 marks available and only about 7% scoring all 15 marks.

Q5(a) and Q5(b) were almost invariably completed correctly, the main source of error in Q5(b) being that a very small number of candidates did not realise that $t = 0$ follows from $2^t = 1$.

Many correct solutions to Q5(c) were seen. The principal reason for loss of marks came from candidates being unable to find the derivative of $2^t - 1$. Dividing $\frac{dy}{dt}$ by $\frac{dx}{dt}$ $\left(\text{i.e. dividing by } -\frac{1}{2}\right)$ proved challenging for a number of candidates. Some candidates, having correctly established $\frac{dy}{dx}$ as being $(-2)2^t \ln 2$, then proceeded incorrectly to equate this to $-4^t \ln 2$. Most knew how to obtain the gradient of the normal, and could write down the equation of a straight line.

Q5(d) was answered well by small number of candidates, and, although a significant number could write the area as $\int_4^0 \left(2^t - 1\right).\left(-\frac{1}{2}\right)dt$, many were unable to perform the integration of 2^t with respect to *t*. Some wrote 2^t as $2t$, thus simplifying the problem, whilst attempts such as $\frac{2^{t+1}}{t+1}$ were not uncommon. Candidates who were unable to make an attempt at the integration of 2^t were unable to access the final 4 marks in this part. Approaches that facilitated integration included re-writing 2^t as $e^{t\ln 2}$ or substituting $u = 2^t$, leading to $\frac{du}{dt} = 2^t \ln 2 = u \ln 2$, and thereby circumventing a direct integration of 2^t.

Other candidates used a cartesian approach, giving the area as $\int_{-1}^{1} \left(2^{2-2x} - 1\right)dx$ (or equivalent), but again a number were unable to carry out the integration.

Question 6

This question was answered well across all abilities.

In Q6(a), most candidates solved $1-2\cos x = 0$ to obtain $x = \frac{\pi}{3}$. A number of candidates, however, struggled to find the second value of $x = \frac{5\pi}{3}$. A variety of incorrect second values were seen, the most common being $\frac{2\pi}{3}$, $\frac{4\pi}{3}$ or $\frac{7\pi}{3}$.

In Q6(b), the majority of candidates were able to apply volume formula of $\pi\int y^2\mathrm{d}x$, although a number of candidates used incorrect formulae such as $2\pi\int y^2\mathrm{d}x$ or $\int y^2\mathrm{d}x$ or even $\int y\,\mathrm{d}x$. Some candidates incorrectly expanded $(1-2\cos x)^2$ as either $1 \pm 4\cos^2 2x$ or $1-4\cos x-2\cos^2 x$ or $1-4\cos x-4\cos^2 x$. Others attempted to integrate $(1-2\cos x)^2$ directly to give incorrect expressions such as $\frac{(1-2\cos x)^3}{3(2\sin x)}$. When the integral included a term in $\cos^2 x$, a few candidates integrated this incorrectly to give expressions such as $\frac{\cos^3 x}{3}$ or $\frac{\cos^3 x}{-3\sin x}$. The majority, however, realised the need for using $\cos 2x = 2\cos^2 x - 1$. Whilst this double angle formula was generally correctly quoted, this did not always lead to a correct expression for integration as a result of sign or coefficient errors. The integration of an expanded trigonometric expression was generally well done, as was the substitution of the limits found in Q6(a). Candidates are advised to show some evidence of how they have substituted their limits, because this allows some credit to be given if errors occur later in the calculation. Although this question specified an exact answer, decimal answers were occasionally given.

Question 7

In this question the majority of candidates were able to score full marks in Q7(a) and Q7(b).

Q7(a) was generally well answered, with most candidates gaining full marks. Having successfully found at least one of either μ or λ, some candidates proceeded no further and did not attempt to find the point of intersection. Some candidates used the third equation to prove that the two lines intersected, not realising that this was not required. Mistakes included minor errors in constructing the simultaneous equations or algebraic errors when solving their simultaneous equations.

In Q7(b), a large majority of candidates were able to find the correct acute angle by taking the dot product between the direction vectors of l_1 and l_2. The majority worked in degrees with only a few answers given in radians. Some candidates applied the dot product formula between multiples of the direction vectors (using their λ and μ from part (a)), which usually led to an obtuse angle; however, most realised that they needed to subtract this angle from 180° in order to find the correct acute angle. A number of candidates used incorrect vectors such as either $9\mathbf{i} + 13\mathbf{j} - 3\mathbf{k}$, $2\mathbf{i} - \mathbf{j} + \mathbf{k}$ or $6\mathbf{i} + \mathbf{j} + 3\mathbf{k}$ in their dot product equation.

The majority of candidates found Q7(c) challenging. To make progress with this question it is necessary to use the scalar product formula to obtain an equation in a single parameter, not the three unknowns *x*, *y* and *z*. So candidates who initially found the vector $\overrightarrow{AP}$ in terms of λ and who applied $\overrightarrow{AP} \bullet \begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix} = 0$ were those who were more successful in gaining some or all of the 6 marks available. It was noticeable, however, that some of these candidates found incorrect values of λ such as 3 or even $-\frac{1}{3}$ following from a correct $21\lambda - 7 = 0$. It was also common to see a number of candidates who incorrectly tried to apply $\overrightarrow{OP} \bullet \overrightarrow{OA} = 0$ or $\overrightarrow{OP} \bullet \begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix} = 0$ in order to find their λ. Candidates who found λ by a correct method were usually able to substitute it into the equation for l_1 in order to find the exact coordinates of *P*.

Question 8

Candidates found this a challenging question. Some candidates did not attempt to separate the variables in Q8(a). They were also not able to deal with the context of the question in Q8(b).

In Q8(a), those candidates who were able to separate the variables, were usually able to integrate both sides correctly, although a number made a sign error by integrating $\frac{1}{3-\theta}$ to obtain $\ln|3-\theta|$. A significant number of candidates omitted the constant of integration "$+c$"and so were not able to gain the final mark. A significant number of candidates did not show sufficient steps in order to progress from $-\ln|3-\theta| = \frac{1}{125}t + c$ to the result $\theta = A\mathrm{e}^{-0.008t} + 3$. Common errors included candidates removing their logarithms incorrectly to give an equation of the form $3 - \theta = \mathrm{e}^{-\frac{1}{125}t} + A$ or candidates stating the constant A as -1.

Q8(b) was often better answered with some candidates scoring no marks in q8(a) and full marks in Q8(b). Those candidates who used $\theta = A\mathrm{e}^{-0.008t} + 3$ were more successful in this part. They were usually able to write down the condition $\theta = 16$ when $t = 0$ in order to find $A = 13$. Some candidates misinterpreted the context of the question to write down the condition $\theta = 6$ when $t = 0$, yielding the result of $A = 3$. Other incorrect values of A seen by examiners included $-1, 16$ or 1. Many candidates who found A correctly were usually able to substitute $\theta = 10$ into $\theta = 16\mathrm{e}^{-0.008t} + 3$ and manipulate the result correctly in order to find the correct time.

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