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Summer 2013

GCE Core Mathematics C2 (6664)
Paper 01

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Introduction

Most candidates seemed well prepared for this paper and attempted all of the questions. The presentation of answers needed more care in a number of cases. Many examiners commented on the poor handwriting of pupils and especially how this made it difficult to distinguish numbers. Heeding the accuracy required in certain questions seemed a problem for many too, as was rounding too early in some questions. Lack of clear explanation and demonstration of method was also apparent in some scripts.

In general, candidates found the paper accessible but many showed a lack of confidence with the trigonometric questions and the log questions. There were many examples of poor algebra.

There also seemed to be a lack of familiarity with angles outside the range of 0° to 90° and manipulation of logs was a problem for a substantial group of candidates.

Of increasing concern to examiners is the apparent rise of answers being given with no working at all. This may be due to the use of the Graphical Display Calculator, but no evidence is given and frequently its use is not helpful and is insufficient to gain the marks available for the question. Methods need to be seen as well as numerical answers.

Examples of lack of working include question 6(b): Sometimes definite integrals such as $\int_{-4}^{0} x(x+4)(x-2)\ \mathrm{d}x$ were given as 42.6666666666 or $42\frac{2}{3}$ without sight of expansion or integral. The question had directed that integration should be used.
In question 8(ii)(b), some candidates just stated the solutions to $\sin\theta\tan\theta = 2\cos\theta + 2$. Some even drew the graphs of $y = \sin\theta\tan\theta$ and $y = 2\cos\theta + 2$, marking the points of intersection, and giving not only angles, but also y-coordinates, in case they were required as well. This ignored the "hence" in the question, that related this demand to the previous part.

In question 9, some made a statement of just "(4, –28), minimum", sometimes accompanied by a diagram of the curve. This ignored the instruction to "use calculus".

Report on individual questions

Question 1

Candidates displayed a good knowledge of Geometric Series and generally applied formulae successfully to gain maximum marks in most responses.
A small number of candidates attempted a common difference rather than ratio, yielding r = -6 and p = 6, but usually went on to use the geometric series sum formula in (c). One error that caused a few candidates to lose marks was to give r =3/2 instead of r = 2/3, though they often then obtained p = 8 in (b). Some students also lost marks due to incorrect rounding, for example by giving r as 0.6, though many obtained the mark in (a), having written 12/18 or 2/3 previously, but then lost marks later by using 0.6 or some other approximation in their calculations.

In part (c), most students used the correct formula for the sum of a geometric progression, although some candidates were unable to use their calculators efficiently to obtain an accurate answer. Other mistakes were to give the sum as $\frac{18(1-(\frac{2}{3})^{14})}{1-\frac{2}{3}}$ or to attempt to use the formula for the sum to infinity or the formula for the sum of an arithmetic series. Attempts to find and then add all 15 terms were very rare. A significant minority went straight from a correct formula in part (c) to an answer rounded to 3 significant figures rather than 3 decimal places, losing the last mark (just one of a number of occasions where candidates were failing to read the detail of the question properly).

Question 2

This question was generally answered very well with many candidates gaining 4 or 5 marks.

In part (a) most candidates were able to find the correct coefficients for each term using either binomial coefficients or Pascal's triangle. Occasionally candidates gave the fully correct first four terms but then omitted the final (x^4) term. This could possibly be due to previous years' papers asking for expansions only up to the term in x^3.

Candidates who took out a factor of 2^4 before applying the binomial theorem were generally less successful in obtaining correct simplified terms. A common mistake was not to use a bracket for $3x$, resulting for example in $3x^2$ instead of $(3(x))^2$ and hence wrong coefficients. A small minority added the powers of '2' and '$3x$' rather than multiplying them.

In part (b) the correct answer was frequently seen without any further working, but it was not uncommon to have minus signs for the last 4 terms or for the expansion to remain exactly the same as in part (a), perhaps with the terms reversed. A number of candidates were able to gain this follow-through mark after having made a calculation error in part (a). Some, surprisingly, applied a full binomial expansion again, failing to spot the connection to the first part of the question.

Question 3

The first two parts of this question were very familiar and the vast majority of candidates answered them well, but part (c) was less familiar and proved very challenging for all but the very good candidates.

Part (a) was accessible to almost all students with most taking the route of setting f(3) = 0 and solving to get $a = -9$. Very few slips were seen in the evaluation of f (3) and most students who started with this approach gained both marks. The common error of failing to equate the expression to zero explicitly led to many students losing a mark. We saw very few students erroneously using f(–3). Some candidates chose to assume the value $a = -9$ and proceeded to show that f(3) did indeed equate to zero, or by long division showed that the result was a three termed quadratic. However, often such candidates lost the A mark because there was no suitable concluding statement, such as "so $(x - 3)$ is a factor". There were relatively few attempts using "way 3" in the mark scheme, dividing f(x) by $(x - 3)$ to give a remainder in terms of a, and full marks by this approach were rare.

In part (b) students were generally well rehearsed in the methods for fully factorising the cubic equation, with many preferring the long division approach. Some slips were observed in the signs, particularly with the x term. More students remembered to factorise their quadratic compared to previous papers, with most achieving three factors in their final expression. The most common error seen was with the signs when factorising the three-term quadratic. It was rare to see a factor theorem only approach.

In part (c) the question presented real challenge and was a useful tool for differentiating between the weaker and more able students. Those more able who had spotted the link between this part and the previous part of the question generally answered it well, using logs effectively, although a significant number lost the last mark by giving a solution for $3^y = -2$.

However, a large number of candidates did not spot the link between f(x) and g(y) and hence attempted to solve g(y) = 0 by many inappropriate and ineffectual methods, and poor simplification such as $2(3^{3y}) = 6^{3y}$ was often seen. One mark was often salvaged for the solution $y = 1$, found usually by spotting that g(1) = 0, although it sometimes emerged from wrong work, such as $3y = 3$, rather than $3^y = 3$.

Question 4

This was another straightforward question with most candidates finding parts (a) and (b) very accessible. Rounding errors in (a) were seen in a small number of cases, but incorrect answers were very rare.

There were some common errors in (b): for example, inclusion of the final y value, 0.5, in the inner bracket, often outside it as well; incorrect values for h, usually $\frac{3}{7}$, but occasionally 5, or even 6; missing external brackets, e.g.: $\frac{1}{2} \times \frac{1}{2}$ (5 + 0.5) + 2(4 + 2.5 + 1.538 + 1 + 0.690), resulting in a final answer of 20.831 rather than 6.239. In many cases, candidates wrote a completely correct expression for the area, but their calculation implied they had included the 0.5 ordinate in the internal bracket.
Use of individual trapezia was used occasionally; however, use of x-instead of y-values was seldom seen.

It is noteworthy that, even in a lot of correct answers, the final closing bracket was missing from the working. With the formula in the printed book these errors should not happen. Brackets are an important part of mathematics.

In part (c) many candidates failed to realise that this part related to their previous answer. Instead, a common response was to try and integrate the function, by handling the algebraic fraction incorrectly, e.g. putting $\int_0^3 \left(4 + \frac{5}{x^2+1}\right) \mathrm{d}x = \int_0^3 \left(4 + \frac{5}{x^2} + 5\right) \mathrm{d}x$.

Some students realised there was a connection between parts (b) and (c) but simply added 4 to their previous answer.

Those who handled this question best showed good understanding of the graph transformation and used geometry to find the area of the added rectangle (3 × 4 = 12) and added that to their answer from part (b). Another method which worked successfully was to add 4 to each function value in the table and then to use the trapezium rule again to calculate the area.

Question 5

This question proved quite difficult for some candidates, although those who were familiar with the required formulae and comfortable in the use of radians often achieved full marks.

It was noticed that some candidates persisted in applying formulae including π, for example sector area = $\frac{1}{2}\pi r^2\theta$, despite using angles in radians.

Although most knew how to approach part (a) correctly, the area of a triangle formula and the area of a sector formula were sometimes incorrectly quoted. Also, many candidates used a wrong calculation to find the obtuse angle, for example ($2\pi - 0.64$) or ($1 - 0.64$). In spite of this many candidates did obtain one numerically correct area, scoring at least 2 marks out of 4. Those who worked in radians were far more successful than those who converted unnecessarily to degrees.

A few candidates treated triangle *ABE* as 'right-angled' and consequently used an incorrect formula. Others complicated the problem by splitting triangle *ABE* into two right-angled triangles. Some used this method successfully but others either miscalculated or used a wrong angle or side in their final calculation. A few candidates found the area of the semicircle then subtracted that of the small sector *EBA*.

Many candidates achieved more marks in part (b) than they did in part (a). The formula for arc length was generally quoted correctly but in many cases the wrong angle was used. The majority of candidates used the cosine rule successfully to determine the length of *AE*, but occasionally the rule was misquoted or there were errors in calculation.

A surprisingly common mistake was a misunderstanding of what was meant by the perimeter so that, for example, an additional 12m radius from inside the shape was added.

Question 6

Most candidates achieved the first 4 marks comfortably with just the rare wrong expansion of brackets, the most common wrong answer being $x^3 + 2x^2 - 8$ (i.e. they “lost” the x from $8x$). There were occasional integration errors.

Thereafter, there was a widespread failure to recognise the need for two separate integrals and many candidates reached the consequential answer of $-6\frac{2}{3} - (-42\frac{2}{3}) = 36$. Others obtained the correct final answer by altering the signs: $-6\frac{2}{3} + (-42\frac{2}{3}) = -49\frac{1}{3}$... etc.

Some of those that found two integrals did not evaluate these correctly, changing the limits around and ignoring the zeros fairly indiscriminately. Another fairly common error was to substitute the limits the wrong way round and some students changed –4 to 4, which fortuitously produced the same value as the integral from –4 to 0, but did not receive credit. A few scripts showed very limited working from which it was difficult to tell whether one or two integrals had been attempted. A number of candidates gave the correct x-values where the curve crossed the axis, but then proceeded to use different values for the limits in their integrals, 3 being quite often used instead of 2.

The best answers showed clearly the substitution and evaluation of the limits, and explained the negative answer for the integral between 0 and 2. The two areas were then combined to get the final answer. A surprising number, having obtained $42\frac{2}{3}$ and $-6\frac{2}{3}$ correctly then added them without changing the sign of the second definite integral.

Many calculations were compromised by a failure to deal correctly with the sign of the powers of –4. Some students had solutions which showed correct method throughout but premature rounding resulted in the loss of the final accuracy mark.

There were several instances of students simply using graphical calculators to find the area with no evidence of any integration (or indeed, in some cases, of any expansion!). Such answers scored no marks as the question made it clear that integration should be used.

Question 7

Logarithm questions tend to produce a whole spectrum of solutions, and part (a) in particular gave a good indication as to which pupils had fully grasped the rules of logarithms. Weaker candidates, however, often were able to gain marks in part (b).

In part (a) many candidates did score full marks but there was also a large number of responses which displayed little or no understanding, with such statements as $\log_2(5x + 4) = \log_2 5x + \log_2 4$ and others such as $\log 2x - \log(5x + 4) - \log 8 = 0$ implies that $2x - (5x + 4) - 8 = 0$.

A number of candidates made the common error when attempting to use the subtraction rule for logs, for example writing $\log 2x - \log(5x + 4) = \dfrac{\log 2x}{\log(5x+4)}$, but then went on to reach $x = \frac{4}{11}$. This was covered by a special case in the mark scheme, but candidates should be reminded that a correct numerical answer may not score full marks if errors are seen in the working, as in this case.

A variety of approaches were observed with some candidates expressing $\log_2 2x$ as $\log_2 2 + \log_2 x$ and others choosing to approach the question by first changing 3 to $\log_2 8$ or -3 to $\log_2(\frac{1}{8})$. It was sad to see good log work followed occasionally by such a basic error as $x = \frac{11}{4}$ following $11x = 4$. Those who scored full marks usually gave an exact fractional solution as opposed to a recurring decimal.

In part (b) the power and addition rules for logs were evidently more widely known and easily applied, as most students were able to access the two method marks. Failure to understand 'express y in terms of a' resulted in many students leaving their answer as $8y = a^5$ or more commonly $\log_a 8y = 5$. Some, however, tried to rearrange to make 'a' the subject of their answer.

Question 8

Although the majority of candidates managed to find the first solution 96.3 in part (i), many struggled with the second solution. Clearly the limits of –180 to +180 were challenging for many candidates, who preferred to give positive answers which were outside the required range. The angle 56.3 was usually found but then it was often subtracted from 180 rather than the other way round. Some candidates, after correctly stating $x - 40 = 56.3$, subtracted 40 to give an answer of 16.3. Just a few thought that $\tan(x - 40)$ was equivalent to $\tan x - \tan 40$.

Part (ii)(a) was generally well answered with the correct substitutions made, although there were some instances of incorrect identities such as $\tan\theta = \dfrac{\cos\theta}{\sin\theta}$ and $\sin\theta = 1 - \cos\theta$. Mistakes were due more to errors with the basic manipulation of the equation than a lack of knowledge of the identities.

A common mistake came in multiplying the right-hand side by $\cos\theta$ to give $3\cos^2\theta + 2$ instead of $3\cos^2\theta + 2\cos\theta$.

In part (ii)(b) the quadratic formula was usually quoted and used correctly leading to at least one correct answer $\theta = 72$. Those who tried to complete the square often made mistakes, especially in dealing with the coefficient 4. Candidates who attempted to factorise usually ended up with answers such as 60, 90 or 180 and gained no more than one method mark for attempting $360 - \theta$. The quadratic formula yielded most success.

Some problems occurred with candidates rounding answers too early and therefore losing accuracy in later steps. Most knew they had to subtract their initial solution from 360 to find other solutions, but some appeared to be randomly adding and subtracting 180, 270 and 360.

Question 9

This fairly standard turning point question saw a large number of excellent solutions, and was more accessible to weaker candidates than in some previous years, although the fractional powers caused difficulties for a significant number of candidates.

Although in most cases a correct first derivative was found in part (a), many candidates struggled to find a solution to $2x - \frac{16}{\sqrt{x}} = 0$. Some candidates spotted that $x = 4$ is a solution, whilst some of those who saw how to solve the equation and achieved the stage $x^{\frac{3}{2}} = 8$ still had issues, with many reaching the result of $16\sqrt{2}$, clearly having evaluated $8^{\frac{3}{2}}$. Candidates who correctly squared their equation to give $4x^2 = \frac{256}{x}$, as opposed to the occasionally seen $4x^2 + \frac{256}{x} = 0$, were often more successful in finding $x = 4$. Providing the x-coordinate found was positive, there was a method mark available for finding y, but often this was not attempted or, less frequently, lost because x was substituted in the expression for $\frac{dy}{dx}$. Other poor attempts saw the use of a second derivative equated to zero which led to a forfeit of the final method mark for finding a y value using an x value resulting from this incorrect process.

In part (b) many candidates were able to correctly differentiate their first derivative, with very few using the alternative gradient method. However, there were some common sign slips with the second term. Incorrect statements were seen such as '$x > 0$ so minimum' or use of $\frac{d^2y}{dx^2} = 0$ leading to an alternative value of x which was then used to determine the nature of the turning point. Others listed all possible outcomes for the second derivative (> 0 so minimum, < 0 so maximum, etc) but failed to identify whether the point P was in fact a maximum or minimum.

Question 10

Part (a) was answered well by the majority of candidates. The x-coordinate of the centre proved an issue for some with –4, 0 or 5 frequently used and 5 or $\sqrt{5}$ were occasionally seen for the right hand side. Many lost marks in (a) for not carefully checking the form of their equation, $(x + 5)^2 + (y - 9) = 25$, and $(x + 5)^2 + (y - 9)^2 = 25$, being examples. Fully correct solutions to part (b) were fairly uncommon and many students did not attempt this part. A common incorrect method was to find the distance from the point (0, 9) to P.

Those scoring here tended to find the distance between (–5, 9) and (8, –7) and then used Pythagoras' theorem to find the required length (although marks were sometimes lost with the wrong side being used as the hypotenuse). Some calculated the distance between the centre and P, but then did not seem to know how to use this. Some students thought this distance was the length PT (which caused them to lose marks).

Most candidates did not use annotation or diagrams to help with part (b) of the question, to understand what the question was asking. Those who did use a diagram often drew it inaccurately and labelled the points with different letters, confusing the centre with the points (0, 9) and the point P (6, –7) with the point T. But on the whole, students who successfully answered part (b) used a diagram, drawing a triangle and marking on the side they needed to find.

A significant number "found" the coordinates of one point of contact T, (–8, 5), often just stating it. A number then tried to explain the solution with 3 4 5 triangles, to which the points concerned lent themselves. It was noticeable that the coordinates of the other point of contact $(-\frac{8}{17}, 11\frac{2}{17})$ were never found in this way.

Grade Boundaries

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