Examiners' Report/
Principal Examiner Feedback

Summer 2012

GCE Core Mathematics C3 (6665)
Paper 01

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Introduction

An accessible paper for almost all candidates with no real evidence of students failing to finish. Calculator work was generally accurate and appropriate with most candidates giving their answers to the required degree of accuracy. There were some weaknesses in algebra, particularly where the simplification of fractions was required. Brackets were generally used very well, and most students used the correct order of operations when dealing with logarithms and trigonometric equations. As always the quality of presentation varied, but most students presented their work appropriately. On questions involving sketching graphs, the shape of some of the curves were on the borders of acceptability. Overall the candidates had been well prepared for the paper and were able to cope with most of what was asked. There were many excellent responses showing a good understanding of the specification.

- Presentation on the whole was good
- A lack or misapplication of brackets in questions such as 1, 7.
- A lack of evidence in 'show that' questions, especially 5.

Report on individual questions

Question 1

This question provided most candidates with a confidence boosting start to the paper. The majority of candidates scoring either full marks, or losing just a single mark as a result of incorrectly expanding the brackets.

For example the error $\dfrac{2(3x+1)-2(3x-2)}{(3x-2)(3x+1)}=\dfrac{-2}{(3x-2)(3x+1)}$ was commonplace

The easiest and most direct way to achieve the correct answer involved writing ($9x^2$ - 4) as ($3x$+2)($3x$-2) cancelling the common factor of ($3x$+2) and then adding two linear fractions. However those who did not recognise the difference of two squares in the denominator, resulting in not being able to cancel, only rarely coped with the complicated algebra needed to achieve an answer. Frequently these candidates produced lengthy, but unsuccessful solutions and only scored the single mark for an attempt to combine two fractions. A few candidates, having factorised the ($9x^2$ - 4) term, retained all 3 linear terms as the common denominator. Most were able to cancel later on in their solution and hence score all of marks.

Question 2

This was completed very well with many candidates achieving full marks. In part (a) most candidates managed to rearrange the formula to x^2 $(x+3)$ = $(12\text{-}4x)$ and, when they got to this stage, generally managed to proceed to the correct answer. Common mistakes included not factorising out x^2 before dividing by (x + 3), and notation errors in which the square root appeared on only the numerator of the fraction. Incorrect methods usually started when the candidates put just 12 on one side of the equation, and factorised the other therefore rendering a correct result impossible. Those candidates who opted for working backwards did not usually state f(x) = 0 at the end of their proof. Attempting to divide f(x) by x+3 was rarely seen, but hardly ever completed correctly.

Part (b), was well answered with a small minority of candidates leaving their answer as root 2 for x_1. A few did make errors in their calculations but these were in the minority. Almost all attempted this part.

Part (c) was familiar to students and there were many fully correct solutions. Although this type of question has been asked in many sessions a number of candidates did not give either a valid reason as well as a valid conclusion.

Question 3

This question proved to be demanding for a sizeable number of candidates, hence producing a wide range of marks.

In part (a) most candidates coped well with the idea of differentiation. It was pleasing to see that candidates had followed previous Principal Examiners Reports, starting the question by quoting the Product Rule before differentiating. For those candidates who did not gain both marks for the differentiation, the most common errors seen were $\frac{\mathrm{d}}{\mathrm{d}x}(\sin 3x) = \cos 3x$, $\frac{\mathrm{d}}{\mathrm{d}x}(\sin 3x) = -3\cos 3x$ and $\frac{\mathrm{d}}{\mathrm{d}x}(e^{x\sqrt{3}}) = x\sqrt{3}e^{x\sqrt{3}}$. Most candidates then went on to 'factorise' out the exponential term and set their derivative equal to zero. Beyond this, many candidates were uncertain as to how to proceed, and many gave up. The preferred method of using $\frac{\sin 3x}{\cos 3x} = \tan 3x$ and thereby setting up a relatively simple trigonometrical equation was only used by stronger candidates. Some candidates also need to take heed of the detail in a question. In particular, this question referred to x>0, so candidates should have known not to state - $\pi/9$ as a solution.

Of those candidates who used alternative methods, a significant number attempted variations of sin($3x$+a) or cos($3x$-a). This method was more complicated, but perfectly valid, and many succeeded in obtaining the correct answer.

Part (b) was generally done very well with many candidates scoring three marks. A surprising number of candidates spent time finding the value of y when x=0 despite the presence of the diagram in the question. A common error was to find the equation of the tangent rather than the normal.

Question 4

The majority of candidates answered this question well, although the graphs were sometimes very untidy and the coordinates difficult to read. Very few candidates omitted to state the required points of intersection with the axes. In part (a) the cusp was better drawn than in previous examinations, but there were occasional errors either with it still crossing the x axis, or bending back on itself. The shape and coordinates were usually correct.

The shape of the graph in part (b) caused the most problems, with many candidates either reflecting the whole graph in the y-axis, or reflecting the negative x-values across the y-axis producing a Ϗ shape. A less common alternative error was to reflect in the line $y=5$, leaving both upper and lower portions in (an "X" shape graph). In part c) there were some errors in the stretches but a large number of candidates answered this part accurately. There were a significant number of candidates who labelled the clearly negative intercept on the x-axis with a positive coordinate. The coordinates were the most problematic aspect of (c). Labelling Q as (0,15) and P as (-4.5,0) were fairly common errors (eg candidates stretched the graph by scale factors 2 and 3 instead of 2 and 1/3.).

Question 5

This question proved to be the most demanding on the paper and served to identify the more able candidates.

Part (a) was intended to help the candidates gain an insight into how the identity could be shown. A mark for $1/\sin^2\theta$ was almost always gained, but the $4\text{cosec}^2 2\theta$ term caused more problems. Some candidates made no attempt to write the identity in just terms of $\sin\theta$ and $\cos\theta$ but were content in leaving their answer in terms of $\sin 2\theta$. A sizeable number of candidates incorrectly wrote $\sin^2 2\theta$ as $2\sin^2\theta\cos^2\theta$, and as a result struggled to proceed.

In part (b), attempts to combine their expression using a common denominator were generally well done. Unless part (a) was done correctly however, this was as far as most reached. The standard of writing out the 'proof' of an identity is improving, but still requires further attention to detail. Many candidates jump important stages in the working, with little or no explanation eg;

$$\frac{1}{\sin^2\theta\cos^2\theta}-\frac{1}{\sin^2\theta}=\frac{1-\cos^2\theta}{\sin^2\theta\cos^2\theta}=\frac{1}{\cos^2\theta}=\sec^2\theta$$

does not explain step 2 to step 3.

Part (c) was generally well answered by candidates although a large number demonstrated an inability to include the negative square root and as a result only found one of the two solutions.

Question 6

Numerous candidates could score high marks on this question, and completely correct solutions were frequently seen. The range and domain were the least well done parts of this question.

In part (a) there was often poor use of notation, with many candidates still confusing the appropriate use of y or f(x) with that of x for the range and domain of the functions (x>2 is unacceptable in (a)). A surprising number of candidates gave the range of f(x) in part a) as f(x) ≥ 3 rather than f(x) > 2.

In part b) most candidates applied the functions in the correct order and were able to simplify their expression correctly. Zero scoring attempts were very rare, but there was a small proportion of candidates who only got as far as $e^{\ln x}$ +2 and either did not simplify, or tried to solve $e^{\ln x} + 2 = 0$ instead.

Part (c) tested candidate's use of lns. It was answered extremely well, although some very poor ln work was evident amongst weaker candidates. Errors in this question were essentially of three types: incorrect expression formed by not understanding composite functions, using 2(f)+3 instead of f(2x+3); missing "+2", giving $e^{2x+3} = 6$; and incorrect ln work in solving.

Many candidates appeared to forget to state the domain in part (d). Some of those who gave a domain followed through their answer to part a), but some gave a correct answer even if they had part (a) incorrect. Missing brackets was extremely rare.

In part (e) some candidates produced very careful and accurate graphs, but a large variety of shapes were produced by a minority, particularly for $f^{-1}(x)$ Some candidates also failed to give correct coordinates for the intersections with the axes, (0,2) and (2,0) were often seen, but other values did occur, or else no coordinates were given at all. Generally there was less success with the intercepts than the shapes. It was also not uncommon to find the two sketches intersecting. There were a few cases only of sketches having a max or min. Some candidates also illustrated the asymptotes, which were not required, but showed a full understanding of the functions

Question 7

Part (a)(i) was answered very well with a large number of fully correct solutions. The majority of candidates did recognise the need to use the Product Rule, with most wisely quoting it. Some errors were seen in the differentiation of ln($3x$) with the most common mistake being $1/3x$.

In part (a)(ii) the Quotient Rule provided more room for error than the product rule. Again, wise candidates started by quoting the rule. The majority of candidates who used the quotient rule applied it correctly. The use of the Chain Rule to differentiate $(2x-1)^5$ was usually successful, although $5(2x-1)^4$ was commonly seen. Some candidates did not understand the rules of indices and as a result $((2x-1)^5)^2$ became $(2x-1)^7$ or $(2x-1)^{25}$. This part required the answer to be fully simplified, although this seems to have been missed by some. A significant number were able to cancel out the common factor of $(2x - 1)^4$ and proceed correctly to the final answer. Other errors were seen in the incorrect expansion of brackets

A minority of candidates attempted the use of the Product Rule to differentiate. These tended to be less successful. Whilst the use of the Product Rule for a quotient is perfectly valid, the extra complications involved in simplification tended to lead to a greater number of errors.

In part (b) many candidates were able to achieve the first three marks. It is pleasing to note that the lack of understanding of this part of the specification experienced in previous papers was less evident this year. Most students knew that if $x=3\tan 2y$ then $\frac{dx}{dy} = ...\sec^2 2y$. This was then more often than not correctly followed by $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{1}{...\sec^2 2y}$

The last part of this question was more demanding. Of those who chose to use the identity "$\tan^2 2y + 1 = \sec^2 2y$" quite a few candidates struggled with the extra factor of 3 in $x = 3\tan 2y$.

Question 8

The vast majority of candidates were able to reach and attempt this question, indicating that the timings for the paper were correct. This question was generally done well by the candidates who attempted it.

Part (a) was generally well done with nearly all finding the correct value for R and the correct angle. Some got tan alpha =7/24 and some got answers of -73.7. A few put their value = $2x$ so getting half of the required angle. A few gave their answer in radians so losing a mark. Students should be made aware of the need to check that their calculators are set to degrees if the answer requires degrees and to read the question more carefully to determine if degrees or radians are required.

In part (b) although many gained full marks there were more problems with this part of the question. The most common error was rounding too soon leading to answer of 113.2 and 173.2. Candidates should be made aware of the need to work to one more degree of accuracy than is required and then to round their final answer. A few changed the sign of alpha when moving from part a to part b. Some didn't make the connection between the two parts. However most were able to gain the first two marks and to go on to find a value for x. Some stopped here even though their answer was not in the correct range. This was a particular problem when α was not correct or – α was used. Some didn't get both solutions. A few mixed degrees and radians. Also, some candidates did not correctly calculate both secondary values with 240 or 120 being occasionally seen.

Part (c) was not particularly well done. Most candidates were able to get the coefficient of the sin2x term but there were many problems with the cos2x term. The most common errors were with the sign of the 1, failing to use brackets or making simple arithmetic errors when rearranging the identities. Cos^2 was often changed to $\sin^2$ to no benefit. Common errors were $\cos 2x=\cos^2 x-1$, $7(\cos 2x +1) = 7\cos 2x + 1$ and $7[\cos^2 x- 1] =7\cos^2 x- 1$. Using a wrong identity for $\cos^2 x$, in terms of cos2x was common with c=-7 a frequent answer. More complicated routes were sometimes taken - using the identity eg $(1-\cos 2x)/2 = \sin^2 x$. Answers of $7\cos 2x - 24\sin x$ were also very common with no appropriate method visible. Candidates should be reminded that they need to show all steps of working once an appropriate identity was found.

Part (d) was poorly answered. Many candidates didn't see the link between parts (d), (a) and (c) even though a hint was given in the wording of the question. Those that did make the connection usually went on to get the correct answer if they had scored full marks in part (c). Both 50 and 25 were common incorrect answers. It was surprising how many candidates saw the expression as 2f(x) and doubled 25 for a maximum value. A minority tried differentiating and some worked on the functions in terms of sin and cos

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