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January 2012

GCE Core Mathematics C3 (6665) Paper 1

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January 2012

Publications Code US030309

Core Mathematics Unit C3
Specification 6665

Comments on Individual Questions:

Question 1

The question was answered very well, with many candidates scoring full marks. It seems that most candidates have followed previously given advice and are now writing down the product and quotient rules before attempting to use them. Failure to do this followed by incorrect expressions risks the loss of many marks in such questions.
Part (a) got candidates off to a positive start, although a common mistake was to differentiate $\ln(3x)$ to get $\frac{1}{3x}$ instead of $\frac{1}{x}$. Also some candidates did not simplify their answer and left it as $2x\ln(3x)+\frac{x^2}{x}$ or even $2x\ln(3x)+\frac{3x^2}{3x}$.
Part (b) was equally encouraging with errors being seen on $\sin(4x)$ differentiating to just $\cos(4x)$. Worryingly however a large number of candidates simplified the denominator of $(x^3)^2$ to x^5.
Additionally some candidates failed to simplify their answer leaving as $\frac{x^2\left(4x\cos(4x)-3\sin(4x)\right)}{x^6}$

Question 2

Most candidates are now very good at sketching graphs at Core 3. The standard of presentation was also better than in similar questions from the past examination series. There were many fully correct solutions.

a) When marks were lost it was usually due to slips: correctly drawn graphs mis labelled e.g. (5, 0) rather than (-5,0). Common errors were giving Q' as (0,-8) or (0,-4). Also there were cases where candidates correctly stated the minimum point as being at (0,-12) but failed to recognise Q as lying on the y-axis, indicating it to the left or right of the y-axis. A few candidates shifted the curve vertically but this was rare.

b) Very well answered in general although the shape was often incorrect with 2 cusps instead of one or 2 smooth minimum points. Most candidates obtained the correct coordinates of P' and Q'. If these were incorrect it was probably carelessness, rather than a misunderstanding. e.g. Q' marked as (2,-4), P' marked (3,0) or Q′ being drawn on the y-axis. A few candidates sketched $f(|x|)$ rather than $|f(x)|$ but this was rare; the drawing of $-f(x)$ was also occasionally seen.

Question 3

The responses to this question were generally excellent with many candidates again scoring full marks.
A = 20 at t = 0 was almost always gained in part (a) although occasionally $20e^{1.5\times 12}$ was calculated. Having gained the mark in (a) a great majority were able to obtain a correct exponential equation and take ln correctly to give t = 0.46 or equivalent, although not all realised that this figure represented hours rather than minutes, thereby losing the final mark for not converting to minutes. There were a few instances where 40/20 was found to be 20, rather than 2, leading to the loss of accuracy marks. A few candidates attempted trial and improvement in (b) but usually failed to choose a tight enough interval to span the correct value.

Question 4

This question was the first to test the better candidates. There were, pleasingly, a number of correct and well explained solutions. Unfortunately however, this area does not seem that well understood by the majority of candidates with $\frac{dx}{dy}$ being changed without reason to $\frac{dy}{dx}$.

Many were able to differentiate $\tan(y+\frac{\pi}{12})$ to $\sec^2(y+\frac{\pi}{12})$ (or find it in the formula book). Common errors seen were the loss of a factor of 2, introduction of a new coefficient of $(y+\frac{\pi}{12})$, or the loss of the $\frac{\pi}{12}$ term altogether.
Being presented with $x = f(y)$ rather than the usual $y = f(x)$ was confusing for some. A few chose to rewrite it by swapping x and y. A more significant number substituted the numbers in before differentiation.

Those who replaced $\tan(y+\frac{\pi}{12})$ by $\frac{\sin(y+\frac{\pi}{12})}{\cos(y+\frac{\pi}{12})}$ before differentiating were often not very successful. A few thought the chain rule had to be applied in some way. Other methods of differentiating the expression (e.g. from $\tan^{-1}$) were very rarely seen.

Candidates who achieved $\frac{dx}{dy}$ correctly, sometimes failed to invert it or just then used it as $\frac{dy}{dx}$. A very common error was $\frac{dx}{dy} = 2\sec^2(y+\frac{\pi}{12})$ being rewritten as $\frac{dy}{dx} = 2\cos^2(y+\frac{\pi}{12})$.

Most candidates were aware that they had to substitute $y = \frac{\pi}{4}$ into their differentiated expression or the reciprocal of their differential but the evaluation was too frequently incorrect. The most common incorrect answers were 2, ½, 4, ¼.
Some did not evaluate fully and left it in terms of cos.
Most candidates who lost all other marks did manage to get the mark for $x = 2\sqrt{3}$ or 3.46

As expected, the most common error was in using the wrong value for the gradient of the normal. For most candidates the working required two inversions of their derivative which caused much confusion and led to loss of marks in writing the normal equation. A more simple approach would have been to write down their value of $-\frac{dx}{dy}$

Those who used the method of finding 'c' generally were usually less successful than using the $y - y_1 = m(x - x_1)$ approach. Relatively few candidates worked with decimals rather than exact answers.

Question 5

This was another demanding question for the weaker candidate although many fully correct solutions were seen. A lack of understanding was seen by some who thought that $cosec(3\theta)$ could be replaced by $3cosec(\theta)$, or the 3θ could be ignored altogether. Other costly errors were seen by candidates who replaced the $cosec(3\theta)$ incorrectly with $1 + \cot(3\theta)$. However candidates were able to use some form the identity $\cot^2 3\theta = (\operatorname{cosec}^2 3\theta - 1)$ to form a valid quadratic equation in $cosec(3\theta)$. A few chose to use $\cot 3\theta = \frac{\cos 3\theta}{\sin 3\theta}$ together with $cosec(3\theta) = \frac{1}{\sin 3\theta}$ and usually went on to obtain a correct equation in $\sin 3\theta$. Correct factorisation leading to $cosec(3\theta) = 3$ or $\sin 3\theta = \frac{1}{3}$ was almost always obtained, gaining the first 4 marks. There were occasional sign errors in factorisation and a few cases of $cosec(3\theta)$ replaced by $\frac{1}{\cos 3\theta}$. The invalidity of $cosec(3\theta) = \frac{1}{2}$ was almost universally recognised, and in general candidates who reached the stage of $cosec(3\theta) = 3$ were able to obtain at least one correct value for θ. About half the candidates getting to this stage went on to obtain 4 correct solutions. The others often gave 2 or 3 correct solutions. Mistakes at this stage included neglecting to divide by 3, thus giving solutions for 3θ instead of θ.

Question 6

This type of question is accessible to most candidates with zero scores being rare.

a) This part was done well on the whole with most candidates picking up both marks. Some candidates gained the first M mark for showing substitution even if both values were incorrect from using their calculators in degree mode. However most candidates correctly calculated $f(0.8)$ and

$f(0.9)$ and were able to give both a reason and a conclusion to justify their answer. For candidates who used a tighter interval, usually 0.81 and 0.89 most referred back to the original interval in the conclusion which is acceptable.

Part b) was a subtle variation on the usual theme, with both differentiation and rearrangement required to score full marks. A few unfortunate candidates tried without any success to rearrange $f(x)=0$. Most however were happy to find $f'(x)$, set it equal to 0 and then rearrange to find the desired result. As this was a given solution then the line 0 $f'(x)=0$ was needed to be seen.

c) Marks were generally lost due to degrees rather than a lack of accuracy. Otherwise this part resulted in 2 or 3 marks for most candidates.

d) The majority of candidates gained the M mark for the correct interval (although an upper limit of 1.90784 was seen occasionally which normally would be acceptable, was not acceptable for this root). A large number lost the last two marks for substituting into the incorrect expression. A few candidates tried repeated iteration which was not the question. Only a small number completed the last part correctly however, with most substituting into $f(x)$ or the iteration formula rather than $f'(x)$. Many who used $f(x)$ made a comment statement there was a change in sign when there wasn't, and some even commented that they should have found a change in sign.

Question 7

(a) This was done very well by the majority of candidates. Most candidates were able to factorise the quadratic and hence find the common denominator of $(2x-1)(x+4)$ without resorting to cubic denominators. The most common error was the 'invisible bracket' leading to a numerator of $x+2$ instead of $x+4$. When they made this mistake candidates were tempted to 'fudge' their working in order to reach the required result.

(b) Most candidates did this part of the question quite well with only the occasional sign slip in evidence. Some candidates misread the question and attempted to differentiate to find $f'(x)$, or found $\frac{1}{f(x)}$

A few candidates failed to write their answer in terms of x and therefore lost the final mark. Others made errors when dividing their algebraic fraction by 2.

(c) Very few candidates scored this mark. Answers such as $x \neq 0,\ x > \frac{1}{2},\ x \neq \frac{1}{2}$ were frequently seen. There seemed to be little awareness that the restriction on the domain of $f(x)$ has an effect on the domain of $f^{-1}(x)$.

(d) Generally an attempt at fg was put equal to $\frac{1}{7}$ although the positioning of the brackets and '-1' was often incorrect. A few candidates attempted to calculate x leading from $gf(x) = \frac{1}{7}$ whilst others substituted $\frac{1}{7}$ for x in $fg(x)$. After that initial step there were frequent arithmetic or sign errors in reaching $ln(x+1)$ =constant. Most were able to follow on with correct ln work to produce an answer for x in terms of e, occasionally again with sign errors.

Question 8

This question was worth more marks than any other question on the paper and for many candidates it seemed to be the most challenging on the paper.

(a) Most candidates were able to gain the first 2 marks, arriving at $\frac{(\sin A\cos B + \cos A\sin B)}{(\cos A\cos B - \sin A\sin B)}$. Many did not then realise, that to progress, they needed to divide both the numerator and denominator by $\cos A\cos B$. Most candidates then wrote down incomplete or incorrect method; statements written down such as 'divide by $\cos A\cos B$' instead of indicating that both the numerator and the denominator should be divided by $\cos A\cos B$. The method of giving a running commentary would have been very helpful in this question, as it was often unclear from their algebra what they were trying to do. It was important that the examiner could see where the $\tan A$ and $\tan B$ expressions had come from. There were few attempts that used the alternative methods set out in the mark scheme.

(b) Most candidates were able to score 2 marks out of 3. When answers are given on the paper candidates are required to show all steps of their working without any unreasonable jumps. The vast majority used the correct value for $\tan\frac{\pi}{6}$. The responses that gave $\tan\frac{\pi}{6}$ as $\frac{1}{\sqrt{3}}$ usually went on to score full marks but those that used $\frac{\sqrt{3}}{3}$ often failed to show how their expression could be modified to the form required by the identity. Others got stuck with the algebra without realising that multiplying each term by $\sqrt{3}$ would have led to the required result.

(c) There were responses that gained full marks. However, it was also very common for candidates to score only the first mark for using the identity given in (b) to obtain $\tan(\theta+\pi/6)=\tan(\pi-\theta)$. At his stage many failed to realise that this could be used to write down a simple equation from which a value of θ could be found. Relatively few candidates produced concise solutions here by using the fact that $\tan(\theta+\pi/6)=\tan(\pi-\theta)$ impliesthat $(\theta+\pi/6)=(\pi-\theta)$. It seemed as though some did not believe it could be that simple. There was a lack of understanding of trigonometry with quite a few attempting to solve using variations of $\tan(\theta+\pi/6=\tan(\theta)+\tan(\pi/6)$. Most candidates who didn't spot the conventional route then in effect restarted the question and tried to expand $\tan(\pi-\theta)$ to form a 3 term quadratic in $\tan\theta$. The majority then gained some credit with some failing to give exact answers for $\tan\theta$ or θ. Good candidates were more likely to obtain both solutions when they used the quadratic.

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