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Examiners' Report/
Principal Examiner Feedback

June 2011

GCE Core Mathematics C1 (6663) Paper 1

June 2011
Publications Code UA027653

Core Mathematics Unit C1
Specification 6663

Introduction

Candidates found this paper challenging but fair and were able to answer the questions in a way that demonstrated their knowledge of the specification. There were some excellent responses from very good candidates, but also there were some very weak answers containing very poor arithmetic as will be exemplified in the comments below. Mostly, presentation was good and candidates made good use of the spaces provided for their answers, but in some cases the presentation was very poor. In many cases failure to read the questions carefully caused loss of marks and particular attention needed to be given to the question set in context – question 9.

Candidates should be advised that when they continue a solution in a different section of the paper they should make this clear on their original attempt by referring to the page on which the solution has been continued. Graph questions should be clearly drawn in HB pencil or in pen and not drawn in colour or in a very faint pencil. Highlighter pens should not be used as they make answers impossible to read. It should not have been necessary for any candidate to use extra sheets of paper as the answer booklet included extra sheets at the end of the later questions. It is possible that some candidates were short of time, but this was often because of multiple attempts on question 4 and unnecessary work in question 3. Candidates spending too long on early answers did not allow themselves sufficient time to tackle the fourteen mark question at the end of the paper.

Report on individual questions

Question 1

In part (a), the answer was 5 and this was usually correct, though ± 5 appeared frequently (and was not penalised). Weak candidates wrote answers such as 12.5.

Part (b) was not done as well as part (a), with the most common error involving the cube root of 25 squared. In some cases this followed a wrong statement such as $25^{-\frac{3}{2}} = 25^{\frac{2}{3}}$ or $\frac{1}{25^{\frac{2}{3}}}$. There were a few instances of poor arithmetic e.g. 25 x 5 = 150 or of carelessness e.g. $5^3 = 15$. The simplest way to calculate 25 to the power 3/2, is to square root 25, giving 5, then to cube the 5 obtaining 125. Some however cubed the 25 first, which involved two multiplications resulting in 15625. They then needed to square root this large number without access to a calculator Very few obtained 125 from this approach. The correct answer was usually given as $\frac{1}{125}$ and the equivalent decimal 0.008 was rare. As in part (a) some included the negative answer in their solution.

Question 2

In part (a) differentiation was completed successfully by most candidates. A common error was not dealing correctly with the negative power. Other slips included $+-3x^{-4}$ not being simplified to $-3x^{-4}$, and a constant of *integration* being included in the answer.

Most of the integrations were also correct in part (b) although fewer gained full marks in this part than in part (a) due to problems with the final simplification. The most common errors were forgetting the constant of integration, not simplifying the coefficient $\frac{2}{6}$ to $\frac{1}{3}$ and not resolving the $+-\frac{1}{2}x^{-2}$ to a single − sign.

The term 7 integrating to $7x$ was missed out entirely on quite a few occasions. Candidates who went straight to a simplified form often incurred errors, while those who wrote down the unsimplified form first were often more successful. It was surprisingly common to see candidates integrating the result of part (a) instead of integrating the original expression.

Question 3

This question was generally done well with many candidates scoring full marks. However there were a number of errors seen and these included solutions where the equation of the line *PQ* was given as their answer for the equation of *l*. A number of candidates did not attempt to find the midpoint and instead used the points given in the question in their equation for *l*. This was the most common mistake. A popular incorrect formula for the midpoint was $\left(\frac{x_2 - x_1}{2}, \frac{y_2 - y_1}{2}\right)$, giving (5, –3). Errors were also seen in finding the gradient, where a large number of responses got the original gradient upside down. Finding the negative reciprocal of a negative fraction resulted in further errors.

After completely correct work some did not give an integer form of the equation for *l* and lost the final mark. Time was wasted here; by those who worked out the equation of *PQ* as well as that of *l*. Candidates need to be reminded to quote formulae and substitute numbers into them carefully, to avoid the more common errors.

Question 4

Most candidates managed to square a relevant bracket and rarely were middle terms omitted. Some weaker candidates squared x and y and 2 separately obtaining $x^2 + y^2 = 4$. Those who chose to eliminate y were more successful than those eliminating x as there appeared to be fewer problems multiplying a bracket by 4 than there were dealing with a negative sign. The most common mistake was that $4y^2 - (2 - y)^2 = 11$ became $4y^2 - 4 - 4y + y^2 = 11$.

Some obtained quadratic equations, which they were unable to solve, after earlier slips in their algebra. Of those who used the quadratic formula most heeded the advice about quoting the formula. A few candidates stopped when they had found the two values of the first variable and never found the second variable. Others restarted the process of solving a quadratic equation rather than substituting their known variable into a linear equation. There was a great deal of crossed out work in this question, with many attempts before success was achieved.

Question 5

Part (a) was usually given correctly as $5k + 3$.

In part (b) the majority of candidates provided working in the form of $5(5k + 3) + 3$ and arrived at the correct printed answer in a legitimate way. A few tried substituting values for k.

Part (c) provided more discrimination. Candidates needed to find a_4 and then needed to add four terms to obtain their sum. There were a number of arithmetic errors in the additions, which was disappointing at this level. Finally showing that their answer was divisible by 6 gave a range of responses. Some had no idea what to do, others divided by 6 and one or two produced a proof by induction. Division by 6 was sufficient to earn the mark here, but again poor arithmetic caused many to lose this mark.

Question 6

Part (a) was answered correctly by most candidates. The most common error seen was $p = -\frac{1}{2}$. Also the original fraction re-written as $(6x + 3x^{\frac{5}{2}})x^{\frac{1}{2}}$ resulting in $6x^{\frac{3}{2}} + 3x^3$ was seen on several occasions.

In part (b) most candidates used their answer to part (a) and integrated successfully. There were a small group who integrated $6x^{\frac{1}{2}} + 3x^{\frac{4}{2}}$ to give $6x^{\frac{2}{2}} + \frac{3}{5/2}x^{\frac{5}{2}}$. Those who gave an unsimplified form $\frac{6}{3/2}x^{\frac{3}{2}}$ gained credit at this stage. A number of candidates then made errors simplifying the fraction and lost the accuracy mark for their evaluated constant and the final accuracy mark. There were slips in arithmetic evaluating the constant. Another group of candidates did not include a constant when they integrated and tried to substitute *x* and *y* into their expression without any clear idea of why they were doing this. They sometimes stopped at the false equation 96 = 90. These candidates usually lost the final three marks. This question revealed several weaknesses in many candidates' ability to work with fractions. Difficulties were seen in simplifying the original powers of *x,* in integrating the simplified powers and in simplifying the fractional coefficient.

Question 7

Candidates were required to give $(k+3)^2 - 4k$ as their answer to part (a). Any *x* terms included resulted in zero marks. Some candidates tried to solve $(k+3)^2 - 4k$ =0 and this was also not given any credit in this part.

Most candidates managed to complete the square correctly in part (b) and those starting with $k^2 + 2k + 9$ usually arrived at the correct answer for this part. However, several left their solution as $(k+3)^2 - 4k$ thus gaining no credit.

Part (c) was poorly done, with a substantial minority of the candidates not understanding what the question required. Quite a few realised that the determinant had to be greater than zero, but didn't know how to show this. M1 A0 was a common mark for those who tried a number of values for *k*. Candidates were expected to use their completion of the square and to argue that $(k+1)^2 \geq 0$ for all values of *k*.

A large minority were intent on trying to solve $k^2 + 2k + 9 = 0$, and concluded that there were no real roots. They demonstrated some confusion between the values of *k* and the information provided by the discriminant. Good candidates scored full marks on this question.

Question 8

Part (a) was done well with many candidates gaining full marks. The most common mistake was stretching the curve by a scale factor 2 in the x direction rather than scale factor $\frac{1}{2}$. The other less common mistake was not putting on the graph the coordinates of the minimum point.

Many candidates scored full marks for part (b). The most common mistake was reflecting the curve in the y axis instead of the x axis. Others rotated the graph about the origin through 180° and again some candidates did not put down the coordinates of their turning point.

Fewer candidates scored full marks for part (c), than for part (a) or part (b). Many put in numerical values for p, normally 1, or 2, or both, scoring the first two marks for the correct shape and position of the curve. Some used $p = 3$ (not in the given range) and did not gain credit.

Most candidates translated the curve correctly to the left although a few translated the curve to the right or even up or down. A sizeable minority obtained the correct coordinates in terms of p. There were a number of candidates who tried to describe the family of curves and sketched the upper and lower boundary curves. They usually had difficulty explaining their answer clearly and often gained a single mark here as they rarely gave the coordinates of the turning point nor the points where the curves crossed the x-axis.

Question 9

This question was found difficult by many. Part marks 3, 0, 2 were common, although some did try to use the sum formula correctly in part (b) to obtain the method mark. Relatively few could establish the number of terms for this part, and proceed to use it correctly.

The majority of candidates knew which formula to use in part (a) and consequently gained the method mark. The problem was realising there were 50 even numbers, common errors were $n = 100, 99, 98$ or even 49. Calculating 25×102 correctly, caused problems for many. Only a small number of weaker candidates did not use the formula but wrote out all the terms and attempted to add. They were rarely successful.

Many candidates seemed unclear how to attempt part (b)(i). Often it was not attempted: nk was a common wrong answer. There were a few candidates who got $n = \frac{100}{\boldsymbol{k}}$ but then failed to use this in part (b)(ii).

In part (b)(ii) many candidates scored only the M1. Those who chose the '1st plus last' formula found the easier proof, the other sum formula leading to problems with the brackets for some students. Some became confused by $\frac{1}{2}n = \frac{100}{k/2}$ arriving at $\frac{200}{k}$ or $200k$ or $50k$. Others attempted to work backwards from the result with little success.

The majority of candidates were successful with part (c) even if they had failed to score many marks in the previous sections. Many could find $d = 2k + 3$ and use a correct formula for the 50^{th} term, but several continued after reaching $100k + 148$ to rewrite it as $50k + 74$ or $25k + 37$. Common errors were using a sum formula or making a sign slip when finding d. This type of question needs to be read carefully

Question 10

Most candidates were able to make a good attempt in part (a). The most common mistake was not finding the intercept on the *y*-axis, or finding the wrong one; (0,10) was a common answer, with a few candidates writing $1 \times 3 \times 3 = 10$. Another common error was to draw the graph touching the *x*-axis at –1 and crossing it at –3 rather than the other way round, or to draw a negative cubic graph (i.e. wrong orientation). Others also showed the graph touching/crossing at $x = +3$ and $+1$. Multiple attempts produce a confused answer which usually gains no credit.

The majority of candidates were able to obtain full marks on part (b). Most understood that they needed to expand the brackets, with surprisingly few errors, although the absence of any negatives probably helped. Most candidates obtained the required cubic polynomial and differentiated correctly to get the printed answer. Those who made errors in their expansion were usually honest and differentiated *their* expansion, thereby gaining the method mark for differentiation. A few candidates did not know what to do, and tried to integrate backwards.

Many candidates clearly understood what to do and correctly substituted $x = -5$ into $f(x)$ and $\frac{dy}{dx}$, to get the correct *y* value and gradient in part (c), resulting in the correct equation.

There were more simple arithmetical mistakes than expected, including a significant number who wrote "$-4 \times 4 = 0$" for their *y* value and also for their gradient wrote "$75 - 70 + 15 = 10$". As well as poor arithmetic skills, many candidates made the arithmetic harder than necessary by choosing to calculate their value of *y* from their expanded cubic expression, rather than using the factorised form given in the question. Not only did this make the arithmetic more difficult, but it also introduced the possibility of an incorrect *y* value being found if their expanded cubic were incorrect. $y = 20x + 116$ was also seen as a result of poor re-arrangement. Weaker candidates attempted to find a second point on the curve and used the gradient of a line segment rather than the gradient of the tangent. Others automatically thought they had to begin by differentiating to find the equation of a tangent, and so they used $\frac{d^2y}{dx^2}$ to find their gradient.

Part (d) seemed to differentiate between the better candidates and the rest. Good ones usually scored full marks, others either did not attempt it, or did not know how to begin. Some weak candidates put their equation from (c) equal to $\frac{dy}{dx}$ or the original equation of curve *C* and attempted to solve. Many thought they had to produce a second equation of a line, usually using a gradient of "20" and choosing a different point, or a value of "*c*", without any apparent reason. Others thought that this next part must be to do with the normal and so found the equation of a line with gradient $-\frac{1}{20}$. Some others understood that they needed to use their value for the gradient and the statement 'parallel so same gradient' was common, but candidates did not relate this to $\frac{\mathrm{d}y}{\mathrm{d}x}$.

Almost all candidates who correctly equated $\frac{\mathrm{d}y}{\mathrm{d}x}$ to 20 went on to correctly factorise and, pleasingly, many candidates then explained why they chose $x = \frac{1}{3}$ rather than $x = -5$ as their answer showing that they had good understanding of the context.

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Order Code UA027653 June 2011

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