Examiners' Report/ Principal Examiner Feedback

January 2013

GCE Core Mathematics C1 (6663) Paper 01

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General Introduction

Many candidates were well prepared for this paper and they were able to make good attempts at all of the questions. Most of these showed clear working to justify their answers and among the more able candidates there was some good graph work, careful algebra and accurate arithmetic. Candidates produced responses that were accurate and also a pleasure to mark because the work was logical and legible.

Some candidates found the arithmetic challenging on this non-calculator paper. For example, the last mark on Q5 was frequently lost by candidates attempting to calculate $\frac{1}{2}\times 7\times\frac{7}{2}$ and answers ranged from 3.5 to 98. In Q7 calculating $140 + 19 \times 20$ frequently resulted in an incorrect answer and in Q11 the square root of $\frac{1}{4}$ gave rise to incorrect answers. Algebraic skills were well tested on this paper and the use of fractional and negative powers was an area that was found challenging by many candidates. Fractions presented challenges throughout for a minority of candidates. Candidates did not appear to be short of time and the majority of candidates attempted at least parts of all the questions.

Report on Individual Questions

Question 1

This question was correctly answered by most of the candidates. The vast majority of candidates got the first mark for identifying the factor of x or $-x$ (or occasionally $4x$), though a significant number of candidates stopped at this point without taking into account that the question was worth 3 marks. A minority did not gain this first mark as they wrote erroneous statements such as $x-4x^3 = x(4x^2-1)$.

Of the candidates who progressed beyond the initial step, most correctly factorised the resulting quadratic using a difference of 2 squares correctly in their final factorisation. Some candidates made errors particularly sign errors. A number of candidates “lost” the 1 and gave $x(-4x^2)$ which demonstrated weak algebraic understanding and some went on to try and solve for x by setting the equation equal to 0. Some candidates did not distinguish between factorising and solving.

A small number of candidates gained the first mark, by a correct initial factorisation and then reversed the negatives in factorising the quadratic to give $x(2x + 1)(2x - 1)$, thus losing the accuracy marks and gaining just 2 of the 3 marks available.

Question 2

The majority of the candidates answered this question efficiently and correctly and gained the two marks. Many others did state that $8 = 2^3$ somewhere in their workings, but lacked any evidence of multiplication of the powers 3 and $2x + 3$ to gain the method mark. There were a number of candidates who incorrectly ended up using $8 = 2^{\frac{1}{3}}$. Common errors included dividing by 4, attempting to cube $(2x + 3)$ or expanding $3(2x + 3)$ wrongly to get $6x + 6$ or $6x + 3$. The most common error was to add the powers (instead of multiplying them), giving 2^{2x+6}. A small minority attempted to use logarithms, but this was rare.

Question 3

In Q3(i) a significant number of candidates were unable to expand the brackets correctly: common errors were $\sqrt{8} \times 2 = 16$ and $-\sqrt{8} \times \sqrt{2} = +4$ or $+\sqrt{16}$.

Most converted $\sqrt{8}$ to $2\sqrt{2}$ after they attempted to expand the brackets, but a common error was to use $\sqrt{8} = 4\sqrt{2}$.

Some found collecting terms challenging so followed a correct $5 + 5\sqrt{2} - 2\sqrt{2}$ by an incorrect $9 + 3\sqrt{2}$.

In Q3(ii) most candidates were able to change $\sqrt{80}$ to $4\sqrt{5}$ but few knew that they needed to multiply the top **and bottom** of $\frac{30}{\sqrt{5}}$ by $\sqrt{5}$ to rationalise the denominator. A number of candidates multiplied the top and bottom of the fraction by $-\sqrt{5}$ and then did not use the correct signs so ended up with $4\sqrt{5} - 6\sqrt{5}$. Some of the candidates who were able to change $\frac{30}{\sqrt{5}}$ to $\frac{30\sqrt{5}}{5}$ were unable to simplify this to $6\sqrt{5}$.

Changing $\sqrt{80} + \frac{30}{\sqrt{5}}$ to $\frac{\sqrt{400} + 30}{\sqrt{5}}$ was not a common method used but a common incorrect approach was to multiply each term of $\sqrt{80} + \frac{30}{\sqrt{5}}$ by $\sqrt{5}$ (i.e. as if it was an equation) and to forget the denominator. Some other candidates who were able to reach $\frac{50}{\sqrt{5}}$ could not then rationalise the denominator to obtain the correct $10\sqrt{5}$.

Question 4

Errors in Q4(a) were few and there was good understanding of what was required here. Any mistakes that were made were usually arithmetic errors when finding u_4 , e.g. 2 × 17 = 36 and then 36 – 1 = 35 or $u_4 = 2 \times 17 - 1 = 34$.

There were few conceptual errors and it was very rare to find that this question was not attempted.

In Q4(b) candidates knew that they needed a value for u_1. The method mark was for an attempt to use $u_2 = 2u_1 - 1$ in order to find u_1 together with an attempt to add their first four terms. Some candidates, instead, correctly worked out that $u_1 = 5$ by working backwards through the pattern of differences that was generated between the terms and then proceeded to answer the question.

A fairly frequent wrong assumption was that $u_1 = 1$, or that $u_1 = 2u_0 - 1 = 2 \times 0 - 1 = -1$.

Most candidates understood that the notation meant that they needed to find a sum. However some tried to use formulae for sum of an arithmetic series, sometimes after finding u_1 correctly, and in some cases even after writing out a correct sum of the four terms. A minority of candidates restarted in Q4(b); leading to adding terms of for example 1, 3, 5 and 7. There were also unfortunately some errors in the arithmetic by those who listed the sum correctly as 5 + 9 + 17 + 33, most commonly leading to an answer of 54, rather than 64.

Question 5

Q5 was an accessible question enabling all but the very weakest candidates to attempt full solutions to all three parts. It was pleasing to see the large number of students who were able to achieve full marks for all parts of this coordinate geometry question.

In Q5(a) the majority identified the correct gradient, with only a small minority getting the sign wrong or using 2 or –2 instead of $\frac{1}{2}$. Most candidates used the equation $(y - y_1) = m(x - x_1)$ to set up the equation of the line and usually obtained a correct un-simplified equation. Candidates who used the $y = mx + c$ method were more likely to make errors. A majority got the equation into the required form, but others did not read the question carefully and omitted this step, or gave non-integer coefficients. For some this was the only mark they lost in this question.

In Q5 (b) most attempted to put $x = 0$ to get y and $y = 0$ to get x and, provided they had got the correct gradient in Q5(a), they were usually successful. Some solved $x + 7 = 0$ incorrectly getting $x = 7$ for A. A very small number of candidates (usually ones that got Q5(a) incorrect) substituted $x = 5$ and $y = 6$ into their equation by mistake. There were also instances of answers such as $A = -7$, $B = 3.5$, and in some cases an answer was given which combined the coordinates in the form (–7, 3.5)

In Q5(c) most drew the triangle on a grid and were then successful in using the correct method to get the area of the triangle even if their answer was not correct. Common errors were in multiplying 7 by 7 and getting 14 or failing to manipulate fractions correctly resulting in an answer of $\frac{49}{2}$. Other common mistakes were in finding the hypotenuse of the triangle rather than the area of the triangle or in having a negative value for the area. A significant number attempted to use the determinant method yet from these; few were successful as the products involving zeros frequently led to errors. It was pleasing to see diagrams drawn to help with Q5(c).

Question 6

In Q6(a) the topic testing transformation of a graph proved to challenging to the candidates as the graph was given in the specific form $y = \frac{2}{x} - 5$ rather than the more general form of $y = f(x) - 5$. The majority of answers had a correct shaped graph but many varieties of translation, left or right were quite common. Those that did perform a translation of 5 units down often omitted to find the x-intercept thus losing a mark. Poor drawing with graphs overlapping or incorrect curvature also lost marks.

The straight line graph was drawn well and was usually in the correct position, but many candidates forgot to find the intercepts, particularly the x-intercept which required some algebraic manipulation.

In Q6(b) candidates were asked to give the equations of the asymptotes. A common error seen was to confuse the x and y to give the asymptotes as $x = –5$ and $y = 0$ instead of $x = 0$ and $y = –5$. A large number of candidates left this section blank and a few stated $x \neq 0$ and $y \neq –5$ which lost one of the two marks. The asymptote $y = –5$ was more often given than $x = 0$ even though the question asked for the **equations** of the asymptotes. Those who translated the graph up, left or right could still obtain the correct asymptotes, as these answers could be obtained independently and correctly from the equation.

In Q6(c), many candidates realised that they had to eliminate one variable in order to find the point of intersection. Most chose to equate the y terms and then demonstrated their competence in solving the resulting three term quadratic. However many answers contained algebraic errors and hence incorrect co-ordinates. Candidates would be advised to look for errors in their working, when they reach an unlikely answer.

Some candidates found manipulating the fractions challenging, but continued after finding one variable.

Question 7

Generally this question proved to be accessible to all candidates and they processed the information that was given in context well. Candidates demonstrated the appropriate formulae effectively and were able to apply them successfully. The majority of candidates gained full marks in Q7(a) and Q7(b) although Q7(c) was more challenging.

The vast majority of candidates used the *n*th term formula correctly in Q7(a). A minority substituted a first term of 160 rather than using 140 and there were a few who made errors in the processing of 19×20, with answers such as 180 and 360 emerging. Some listed all 20 terms in order to find the 20th term.

In Q7(b) the majority of candidates quoted and applied the sum of n terms formula correctly. It was easier to use the formula $S_n = \frac{n}{2}(a + l)$ with their answer to Q7(a) as l, but the other formula worked well too. The calculation of the correct expression $\frac{20}{2} \times 660$ sometimes resulted in a wrong answer. A few candidates listed the 20 terms and added them, sometimes successfully, though this was time consuming.

For Q7(c) the easier method was to use the formula $S_n = \frac{n}{2}(a + 1)$, as this led directly to the answer. Those who tried to combine both $S = \frac{1}{2}n(2a + (n - 1)d)$ and $l = a + (n - 1)d$ needed to eliminate d, to make progress. Many mistakenly thought that d was 400 or 700. There were some elegant solutions obtained by substituting $(n - 1)d = 400$ and there were some lengthy solutions which led to a quadratic yielding 2 solutions (1 and 17).

In many solutions errors were seen at the final stage of the arithmetic when the correct $8500 = \frac{n}{2}(300 + 700)$ was followed by a wrong answer. This answer was sometimes the fraction $n = 4\frac{1}{4}$ instead of the correct $n = 17$ with many candidates dividing by 2 instead of multiplying by 2, when making n subject of the formula.

Question 8

Some candidates were able to obtain full marks on this question. Less able candidates found it challenging to separate the fraction into its two parts ready for integration. Those that were able to obtain a three term polynomial often made mistakes with the coefficients which they found numerically difficult to manipulate. A common step before they attempted the integration was to write $-x^3 + 8x^{-2} - 10x^{-3}$ with incorrect coefficients of the second and third term. Usually integration of the first term was fine and the general principle of integration was understood, but negative powers caused difficulties e.g. $-3 + 1 = -4$ was a common error.

Some tried to integrate the terms in the fraction without simplifying first. So they integrated the numerator and they integrated the denominator. The majority of candidates were able to obtain the method mark for finding the constant of integration but the subsequent arithmetic was often found to be a challenge for the candidates.

Question 9

In Q9(a) most candidates attempted to find $b^2 - 4ac$ using $a = k + 3$, $b = 6$ and $c = k - 5$ (candidates would be advised to write down formulae first, so that examiners can determine whether or not the correct one is being used if there are errors in substitution). Some however ignored the RHS of the original equation and used $c = k$, not having first produced a quadratic equal to zero. Others made errors and used $c = k + 5$.

A few candidates misunderstood the meaning of coefficient and used $a = (k + 3)x^2$. Algebraic errors were common. A small number of candidates assumed $b^2 - 4ac = 0$, which didn't necessarily lose the first marks but led to errors later in the question when they tried to 'convert' their equation into an inequality.

However, the most common mistakes in Q9(a), concerned sign errors when expanding the brackets. A large number of candidates went from, for example, $36 - 4(k^2 - 5k + 3k - 15) > 0$ to $36 - 4k^2 - 20k + 12k - 60 > 0$. These sign errors were very common (particularly as $36 - 60$ gave the -24). Candidates who multiplied $(k + 3)$ and $(k - 5)$ first then multiplied by 4 usually made fewer errors than those who tried to multiply by 4 or -4 first before multiplying by $(k - 5)$.

A significant number of candidates failed to gain the final accuracy mark for Q9(a). This mark required correct use of the inequality. Some included the inequality in the final couple of lines, having omitted it throughout. Others used $b^2 - 4ac < 0$ from the start, presumably assuming they needed to do this since the given printed inequality was less than zero. However most candidates who used $b^2 - 4ac > 0$ from the start tended to remember to reverse the inequality sign when dividing by -4, gaining the last mark.

In Q9(b) most candidates successfully factorised the given quadratic. A few factorised incorrectly leading to the wrong critical values, and some gave $(k + 6)(k - 4) < 0$, usually leading to the answer $-6 < k < 4$ instead of the correct $-4 < k < 6$. Some candidates then substituted values for k to solve the inequality; others drew a number line and shaded the required interval. There were a variety of intervals given as answers for the last two marks in Q9(b). It was quite common to see answers such as $k < 6$, $k < -4$, or $k < -4$ and $k > 6$. Very few candidates used set notation: $k \in (-4, 6)$.

Question 11

On the whole Q11(a) was very well done with the majority of candidates gaining full marks. Only a very small minority attempted integration and hardly anyone received less than two marks from the three available. The majority of candidates reached $2 - 4x^{-\frac{1}{2}}$. Common errors seen were $2 - 4x^{\frac{3}{2}}$ or $2 - 4x^{-\frac{1}{2}} + 5x$. The fractional powers were usually dealt with correctly on this part of the question.

In Q11(b) many reached the correct answer of $y = -6x + 3$. Errors were made substituting $x = \frac{1}{4}$ into $4x^{-\frac{1}{2}}$ to obtain gradient and further errors made substituting into the expression for y. Some candidates found working with fractions challenging, e.g. $\frac{1}{4}^{\frac{1}{2}}$ = 2, so gradient equal to 2 – 4/2 = 0. Some did not substitute $x = \frac{1}{4}$ into the function to get a y value but used (0, 5) to find the equation.

More able candidates answered Q11(c) well, realising that they were required to set their gradient function obtained in Q11(a) to $\frac{2}{3}$, the gradient of the given line. Some who got as far as $\frac{2}{3} = 2 - 4x^{-\frac{1}{2}}$ made errors in their algebra and these included $\frac{1}{\sqrt{x}} = \frac{1}{3}$, leading to $x = \frac{1}{9}$, or even $x = 3$ and $\sqrt{x} = 3$ leading to $x = \sqrt{3}$. Of those who successfully reached $x = 9$, some attempted to find the y value by substituting into $y = \frac{2}{3}x + 6$ instead of substituting into the original equation. There was a significant proportion of the candidates who, after rearranging the equation of the straight line into the form $y = mx + c$, were unable to progress to gain any marks at all for Q11(c). Of those who proceeded unsuccessfully, it was common to see $y = 0$, so $\frac{2}{3}x + 6 = 0$ leading to $x = -9$. Others found the points of intersection of $2x - 3y + 18 = 0$ and $y = -6x + 3$ or found the co-ordinates of points of intersection of $2x - 3y + 18 = 0$ with the x and y axes thus getting (0, 6) and (–9, 0). These answers did not answer the question set and gained no credit.

Question 10

Many candidates were successful in answering Q10(a). The favoured method was completion of the square. Most got $a = 4$ and $b = 1$, but in obtaining the answer for c, errors were seen of dividing the correct answer –1 by 4. About a third of responses were completely correct, and others had errors arising from the factor 4, leaving the remainder having other errors. There were far more errors in finding the value for c than in finding the value for b. The most common incorrect answers for b were 4 and 2 and the most common incorrect answers for c were –13, 2 and $-\frac{1}{4}$. Two other methods were far less common than completing the square. These were 'expanding $a(x + b)^2 + c$ and equating coefficients' and 'trial and error'. Many candidates had success with the expansion method.

Q10(b) was mostly answered well. The curve was mainly positioned the right way up and in the right place. The quality of graphs could have been better in many cases but few 'V' shapes were seen. Sometimes it was difficult to read the fractional coordinates as the candidates were writing them too small and too near their curve. A few candidates tried to use their answers from Q10(a) to help them draw the graph in Q10(b). This was not always successful as many had made errors in Q10(a) and others did not use the information correctly. Most candidates worked from the equation $y = 4x^2 + 8x + 3$ instead. Few of the answers seen did not include a graph, a very small minority drew an upside down U graph and a minority of candidates drew a cubic curve or a line. Other errors in the graph drawing included having the minimum above the x-axis, or on the x-axis, or on the y-axis. Almost all candidates correctly marked the y-intercept at (0, 3).

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