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GCE Core Mathematics C1 (6663)
Paper 01

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Introduction

This paper proved a good test of candidates' knowledge and candidates' understanding of Core 1 material. There were plenty of easily accessible marks available for candidates who were competent in topics such as differentiation, integration, recurrence relations, arithmetic series and basic transformation of curves. Therefore, a typical E grade candidate had enough opportunity to gain marks across the majority of questions. At the other end of the scale, there was sufficient material, particularly in Q8 and Q9 to stretch and challenge the most able candidates.

While standards of algebraic manipulation were generally good, some weakness in this area was seen in Q5(c), Q8(a), Q9(b) and Q9(c). In Q6, it was disappointing to see a number of good candidates who made arithmetic errors in calculations such as $10 + 14(5)$ in part (a) and $\frac{60}{2}\left[2(10) + 59(5)\right]$ or even 30×315 in part (b). Also a significant minority of candidates in Q7(b) incorrectly simplified $-\frac{6x^{\frac{1}{2}}}{(\frac{1}{2})}$ to $-3x^{\frac{1}{2}}$.

In summary, Q1, Q2(a), Q4, Q5, Q6(a), Q6(b), Q9(a), Q9(b) and Q10 were a good source of marks for the average candidate, mainly testing standard ideas and techniques; and Q2(b), Q3, Q6(c), Q6(d), Q7, Q9(c) and Q9(d) were discriminating at the higher grades. Q9(e) was the most demanding question with only about 3% of the candidature able to correctly find the area of the quadrilateral $ACBE$.

Report on individual questions

Question 1

About three-quarters of the candidature achieved all 4 marks in this question.

While most candidates were able to integrate both $6x^2$ and 5 correctly, a significant minority struggled to integrate $\frac{2}{x^2}$ correctly giving incorrect answers such as $\frac{2x^{-3}}{3}$ or $-\frac{1}{2x}$ or $4x^{-1}$ or $4x^{-3}$.

Incorrect simplification of either $\frac{6x^3}{3}$ to $3x^3$ or $-2x^{-1}$ to $-\frac{1}{2x}$; or not simplifying $+-2x^{-1}$ to $-2x^{-1}$ and the omission of the constant of integration were also other common errors.

It was pleasing to see very few candidates who differentiated all three terms.

Question 2

This question proved discriminating with about a third of the candidature gaining all 4 marks.

In part (a), the majority of candidates were able to evaluate $32^{\frac{3}{5}}$ as 8. Many of those who were unable to achieve 8, were able to score one mark by rewriting $32^{\frac{3}{5}}$ as either $\left(\sqrt[5]{32}\right)^3$ or $\sqrt[5]{32^3}$. Those candidates who chose to cube 32 first to give 32768 were usually unable to find $\sqrt[5]{32768}$. Common errors in this part included rewriting $32^{\frac{3}{5}}$ as either $\frac{3}{5}\times 32$ or $3\left(\sqrt[5]{32}\right)$; or evaluating 2^3 as 6.

Part (b) proved more challenging than part (a), with the majority of candidates managing to obtain at least one of the two marks available by demonstrating the correct use of either the reciprocal or square root on $\left(\frac{25x^4}{4}\right)$. The most able candidates (who usually reciprocated first before square rooting) were able to proceed efficiently to the correct answer. The most common mistake was for candidates not to square root or not to reciprocate all three elements in the brackets. It was common for candidates to give any of the following incorrect answers: $\frac{5}{2}x^{-2}$, $\frac{25}{4}x^{-2}$, $\frac{2}{5}x^{\frac{7}{2}}$, $100x^{-2}$, $\frac{2}{5x^4}$ or $\frac{5x^4}{2}$.

Question 3

This question proved discriminating with just under a half of the candidature gaining all 5 marks. About a third of the candidature gained only two marks by either correctly rationalising the denominator or by correctly simplifying $\sqrt{12}$ and $\sqrt{8}$.

A significant number of candidates answered this question by multiplying $\frac{2}{\sqrt{12}-\sqrt{8}}$ by $\frac{\left(\sqrt{12}+\sqrt{8}\right)}{\left(\sqrt{12}+\sqrt{8}\right)}$ to obtain $\frac{1}{2}\sqrt{12}+\frac{1}{2}\sqrt{8}$ and proceeded no further. A small number of candidates multiplied the denominator incorrectly to give either $12+\sqrt{20}-\sqrt{20}-8$ or $12+\sqrt{72}-\sqrt{72}-8$.

Those candidates who realised that $\sqrt{12}=2\sqrt{3}$ and $\sqrt{8}=2\sqrt{2}$ usually obtained the correct answer of $\sqrt{3}+\sqrt{2}$, although a few proceeded to the correct answer by writing $\frac{1}{2}\sqrt{12}+\frac{1}{2}\sqrt{8}$ as $\sqrt{\frac{1}{4}\times 12}+\sqrt{\frac{1}{4}\times 8}$.

A number of candidates started this question by firstly simplifying $\sqrt{12}$ and $\sqrt{8}$ to give $\frac{2}{2\sqrt{3}-2\sqrt{2}}$, but many did not take the easy route of cancelling this to $\frac{1}{\sqrt{3}-\sqrt{2}}$ before rationalising. Although some candidates wrote $\frac{1}{\sqrt{3}-\sqrt{2}}$ as $\sqrt{3}-\sqrt{2}$, those candidates who rationalised this usually obtained the correct answer.

A small minority of candidates attempted to rationalise the denominator incorrectly by multiplying $\frac{2}{\sqrt{12}-\sqrt{8}}$ by either $\frac{\left(\sqrt{12}-\sqrt{8}\right)}{\left(\sqrt{12}+\sqrt{8}\right)}$ or $\frac{\left(-\sqrt{12}+\sqrt{8}\right)}{\left(-\sqrt{12}+\sqrt{8}\right)}$.

Question 4

This question was well answered with about two-thirds of the candidature achieving all 6 marks.

In part (a), a small minority of candidates struggled to deal with the fractional power when differentiating $-6x^{\frac{4}{3}}$. Some candidates incorrectly reduced the power by 1 to give a term in $x^{\frac{2}{3}}$; whilst other candidates struggled to multiply -6 by $\frac{4}{3}$ or incorrectly multiplied -6 by $\frac{1}{3}$. Few candidates did not simplify $-\frac{24}{3}x^{\frac{1}{3}}$ to give $-8x^{\frac{1}{3}}$ or integrated throughout, or added a constant to their differentiated expression.

In part (b), the most common error was to for candidates to differentiate $-8x^{\frac{1}{3}}$ to give $-8x^{-\frac{1}{3}}$. Few candidates did not understand the notation for the second derivative with some integrating their differentiated result in part (a) to achieve an answer similar to the expression given in the question.

Slips occurred with the omission of *x* from fractional power terms with some candidates writing $-8^{\frac{1}{3}}$ in part (a) or $-\frac{8^{-\frac{2}{3}}}{3}$ in part (b).

Question 5

This question was answered more successfully by candidates than similar ones in the past. The notation did not appear to be such a mystery with most candidates realising that this question tested the topic of recurrence relations and not arithmetic sequences. About two-thirds of the candidates gained at least 6 out of the 7 marks available.

Part (a) was generally very well answered and indeed most who got this part right went on to score most of the marks in the question. Those who were unsuccessful often tried to work back from the given $a_3 = 12 - 3c$ to arrive at $a_2 = 6 - 2c$.

In part (b), most candidates scored full marks. Occasionally problems were caused by the incorrect use of brackets.

In part (c), the majority of candidates were able to find a_4, sum the first four terms of the sequence and write their sum ≥ 23 or $= 23$. Some candidates found a_4 incorrectly by omitting brackets resulting in $a_4 = 2 \times 12 - 3c - c = 24 - 4c$. Instead of summing the first four terms, a number of candidates solved $a_4 \geq 23$ or put each term ≥ 23. Few candidates summed by adding either a_1, a_2 and a_3 or a_2, a_3 and a_4 or even a_2, a_3, a_4 and a_5. Some arithmetic errors were made in summing the four terms and a number of candidates miscopied a_4 as $27 - 7c$. There was, however, a number of candidates using the formula for the sum to *n* terms of an arithmetic series in order to sum their four terms. A significant number of candidates, who achieved $45 - 11c \geq 23$, did not know that dividing by a negative number reverses the sign of the inequality. Those who rearranged $45 - 11c \geq 23$ into $45 - 23 \geq 11c$ were more successful in achieving the correct result.

Question 6

This question was both well answered and discriminating with about three-quarters of the candidature gaining at least 7 of the 10 marks available and one-quarter achieving full marks.

Part (a) was well answered with the majority using $a + 14d$ and a small minority using $5n + 5$ in order to find the 15th term. Few candidates listed each term and a number identified the 15th term correctly. A small number of candidates found the total amount saved over the 15 weeks.

In part (b), many candidates frequently used $\frac{n}{2}(2a + (n-1)d)$ to find the total amount paid over 60 weeks, although a few applied $l = a + (n-1)d$ and substituted the result into $\frac{n}{2}(a + l)$. It was not uncommon, however, for arithmetic errors such as mulitplying 315 by 30 or even adding 20 to 295. Other candidates who failed to get full credit often mixed $n = 15$ and $n = 60$, used $d = 5$ or found T_{60} instead of S_{60}.

In part (c), most candidates successfully created an expression in pence for S_m and set it equal to either 63 or 6300. Of those that set the expression to 63, a large majority did not successfully convert from pounds to pence and as a result did not reach the answer given on the paper. Some fudged their attempts by implying $m(m+1) = 1260$ from an incorrect $10m(m+1) = 126.$
In part (d), a significant number of candidates were unable to deduce $m = 35$ by looking at the given result in part (c). Instead, a number of these candidates wasted unnecessary time in attempting to factorise and solve a quadratic equation to give $m = -36,\ 35$ with some not realising that they needed to reject the negative result.

Question 7

This question discriminated well with just over half of the candidature gaining at least 6 of the 8 marks available. A significant number of candidates started by integrating $\mathrm{f}'(x)$ to give $\mathrm{f}(x)$. In most cases they realised that this was valid work for part (b) and so relabelled their initial work as (b).

In part (a), the majority of candidates evaluated $\mathrm{f}'(4)$ and used a correct line formula in order to find the equation of the tangent. A few made arithmetic errors when evaluating $\frac{1}{2}(4) - \frac{6}{\sqrt{4}} + 3,$ some incorrectly manipulated $y + 1 = 2(x - 4)$ into $y = 2x - 7$ and some found the equation of the normal. Some candidates rewrote $-\frac{6}{\sqrt{x}}$ as $-6\sqrt{x}$ and used this throughout the question and others deduced a tangent gradient of $\frac{1}{2}$ by looking at the coefficient of *x* in the $\mathrm{f}'(x)$ expression.

A significant minority of candidates started part (a) by differentiating $\mathrm{f}'(x)$ and substituting $x = 4$ into the resulting expression. Other candidates incorrectly used $(4, -1)$ by setting their expression for $\mathrm{f}'(4)$ equal to $-1,$ which resulted in a meaningless equation.

In part (b), most candidates integrated $\mathrm{f}'(x)$ to find $\mathrm{f}(x)$ but unfortunately a significant minority failed to find the value of c using $(4, -1)$. Of those who used $(4, -1)$ to find c, a number made arithmetic errors. Other candidates found $\mathrm{f}(4)$ in terms of c and equated their result to 0 instead of -1. A small number of candidates failed to integrate 3 correctly and some candidates either incorrectly simplified $\frac{\frac{x^2}{2}}{2}$ to x^2 or $-\frac{6x^{\frac{1}{2}}}{(\frac{1}{2})}$ to $-3x^{\frac{1}{2}}$. A very small number of candidates found the value of c correctly but failed to include this evaluated c in an expression for $\mathrm{f}(x)$.

Question 8

This question was poorly answered with about 10% of the candidature gaining all 8 marks.

In part (a), the $-x^2$ term and the order of the terms in $4x - 5 - x^2$ created problems for the majority of candidates. The most popular (and most successful) method was to complete the square. A large number of candidates struggled to deal with the $-x^2$ term with bracketing errors leading to incorrect answers such as $-(x+2)^2 - 9$ or $-(x-2)^2 - 9$. A successful strategy for some candidates involved negating the quadratic to get $x^2 - 4x + 5$ which was usually manipulated correctly to $(x-2)^2 + 1$. Whilst a good number negated this correctly to $-(x-2)^2 - 1$, some candidates wrote down incorrect results such as $-(x+2)^2 - 1$, $(x+2)^2 - 1$ or $-(x-2)^2 + 1$.
Whilst a number of candidates stopped after multiplying out $q - (x-p)^2$, those who attempted to use the method of equating coefficients were less successful.

In part (b), most candidates wrote down $b^2 - 4ac$ for the discriminant and the majority achieved the correct answer of -4, although some incorrectly evaluated $4^2 - 4(-1)(-5)$ as 36. The most common error was for candidates to substitute the incorrect values of $a = 4$, $b = 5$ and $c = -1$ in $b^2 - 4ac$. Those candidates who applied the quadratic formula gained no credit unless they could identify the discriminant part of the formula.

In part (c), a majority of candidates were able to draw the correct shape of the graph and a number correctly identified the *y*-intercept as -5. Only a small minority were able to correctly position the maximum turning point in the fourth quadrant and some labelled it as $(2, -1)$. A number of correct sketches followed from either candidates using differentiation or from candidates plotting points from a table of values. A number of candidates after correctly identifying the discriminant as -4, (including some who stated "that this meant no roots") could not relate this information to their sketch with some drawing graphs crossing the *x*-axis at either one or two points. Common errors included drawing graphs of cubics or positive quadratics, drawing negative quadratics with a maximum at $(5, 0)$ or with a maximum at $(0, -5)$.

Question 9

This question proved discriminating across all abilities with about a quarter of the candidature gaining at least 12 out of the 15 marks available. A significant number of candidates gave up on this question before they reached part (e).

Part (a) was well answered by the majority of candidates. After the substitution $y = 4$, most were able to obtain $p = \frac{19}{2}$, although some simplified this to 8.5.

Again, part (b) was well answered with many candidates rearranging $4y + 3 = 2x$ into the form $y = mx + c$, in order to find the gradient of L_1. Occasional use of two points on L_1 was seen as an alternative approach to finding the gradient of L_1, whilst some felt it necessary (normally successfully) to differentiate their L_1 after rearranging. Most candidates were able to use the perpendicular gradient rule to write down the gradient of L_2 and use this gradient to find an equation of L_2. Methods of approach were roughly equally divided between those using $y - y_1 = m(x - x_1)$ or $y = mx + c$. The majority of candidates were able to simplify their equation into a correct form of $ax + by + c = 0$, although some rearranged $y - 4 = -2(x - 2)$ incorrectly to give $y + 2x = 0$. Common errors in this part included candidates incorrectly finding the gradient of L_1 by finding the gradient between A and C or stating the gradient as 2 from looking at the coefficient of x in $4y + 3 = 2x$.

In part (c), a large number of those with a correct equation of L_2 found the correct coordinates of *D*, with a few, fortunately, using their correct un-simplified version of L_2 rather than their incorrect rearrangement. The majority of candidates without a correct part (b) were able to demonstrate that they could solve the equation for L_1 and L_2 simultaneously and received some credit for this. There were a number of candidates who equated their equations for L_1 and L_2 to give $4y + 3 - 2x = 2x + y - 8$. Some manipulated this into $4x - 3y - 11 = 0$ and then gave up; whilst others continued to set $x = 0$ to find a value for y and similarly set $y = 0$ to find a value for x.

In part (d), it was pleasing to see many candidates able to make a good attempt at finding the distance between the points *C* and *D*. Some drew diagrams and others quoted a correct formula. Relatively few candidates got mixed up when determining the differences in the x-values and the differences in the y-values although a few used the incorrect formulae such as $\sqrt{(x_1 + x_2)^2 + (y_1 + y_2)^2}$ or $\sqrt{(x_1 - x_2)^2 - (y_1 - y_2)^2}$. Some candidates lost the final mark in this part by being unable to correctly manipulate fractions and surds whilst others did not provide sufficient working to arrive at the answer given on the paper.

Part (e) was the most challenging question on the paper with the majority of candidates not attempting it and many of those that did were only able to offer incomplete solutions. A significant number of candidates did not draw a clear diagram which is essential in understanding the nature of this problem. Those that were successful usually summed up the area of two relevant triangles (usually triangle ABC and triangle ABE) or found half the product of AB and CE, although a significant number of candidates used the incorrect method of finding the product of AB and CE. A few candidates used other more elaborate methods to find the correct area of 45. Some candidates attempted to find lengths of various lines without any apparent purpose and gave no indication of finding an area. A small number thought quadrilateral $ACBE$ was a trapezium.

Question 10

This question was both well answered and discriminating with about two-thirds of the candidature gaining at least 6 of the 8 marks available and about one-third achieving full marks.

In part (a), most candidates solved $f(x) = 0$ to find the correct x-coordinate of $\frac{9}{2}$ for A. Some candidates, however, found $f(0)$ and arrived at an incorrect value of 9. Other common incorrect values for x were 6 or 27.

In part (b), most candidates were able to give the correct shape for each of the transformed curves.

In part (i), most translated the graph of $y = f(x)$ in the correct direction. Very few candidates translated $y = f(x)$ to the right, and even fewer translated $y = f(x)$ in a vertical direction. Some labelled the y-intercept correctly as $(0, 27)$ but erroneously drew their maximum point slightly to the right of the y-axis in the first quadrant. Most realised that the transformed curve would cut the positive x-axis at "their x in part (a) – 3". Other candidates, who gave no answer to part (a), labelled this x-intercept as $A - 3$ or some left it unlabelled. Occasionally the point $(-3, 0)$ was incorrectly labelled as $(3, 0)$ although it appeared on the negative x-axis.

In part (ii), most graphs had their minimum at the origin and their maximum within the first quadrant. Many realised that the transformed curve would cut the x-axis at $\frac{\text{their } x \text{ in part } (a)}{3}$. Other candidates, who gave no answer to part (a), labelled this intercept as $\frac{A}{3}$, whilst some left it unlabelled. Some misunderstood the given function notation and stretched $y = f(x)$ in the x-direction with scale factor 3 resulting in a maximum of $(9, 27)$ and an x-intercept at $(13.5, 0)$. Very occasionally a stretch of the y-direction; or a two way stretch; or even a reflection of $y = f(x)$ was seen. In a few cases there was an attempt by some candidates to make the graph pass through both $(0, 0)$ and $(0, 27)$.

A significant number of candidates wrote down $k = -17$ whilst some left this part unanswered. A number of candidates wrote down the equation $y = f(x) + k = x^2(9 - 2x) + k$, and substituted in the point $(3, 10)$ to find the correct value of k. Common incorrect answers included $k = 17$ (from $27 - 10$) or $k = 7$ (following $3 + k = 10$).

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