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Examiners' Report

Summer 2015

Pearson Edexcel GCE in Core Mathematics C2 (6664/01)

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General Introduction

The paper was found to be accessible and there were some good solutions to all questions. Students did not appear to be short of time. There was reasonable access at the start of most questions. While there were some very good answers there were also weak answers. The major problems were incomplete working shown and this was particularly true in the solution of equations where answers appeared without explanation. There was frequently lack of clarity when questions asked students to show a printed answer as in the first part of the last question.

There were many cases of poor algebra when dealing with changing the subject of a formula, solving quadratics and fraction work. There was lack of understanding that solving a cubic equation using a calculator needs correct interpretation of the result to arrive at the correct complete factorisation of the cubic expression.

Report on Individual Questions

Question 1

Most students answered this question correctly. Others lost just one mark for one of the coefficients of x or x^2. The most common mistake was using ($x/4$) rather than ($-x/4$), and some other students failed to square the minus sign. About 10% failed to fully simplify their answers, leaving them in the form 1024 – 5120x/4 + 11520x^2/16. A tiny proportion failed to get the mark for the constant 1024. Students who extracted the 2^{10} from the bracket usually did well and many went on to produce a fully correct simplified answer. These might have been A2 students resitting. A very small number attempted to use Pascal's Triangle to get the coefficients but rarely found the 10 and the 45.

Question 2

Generally this question was well attempted and most students showed a sound understanding of the underlying concepts.
In part (a) most students recognised the correct structure for the equation of a circle and stated

$(x - 2)^2 + (y + 1)^2 = r^2$ with only some slipping a power or the sign in between the brackets. A few used (4, -5) as the coordinates for the centre and some gave a value for r rather than for r^2 in the circle equation. Common sign errors in the calculation of the radius were seen, resulting in $r^2 = 40$. Some thought AC gave them the diameter so continued to halve the distance found, losing the second method mark. A few students found the linear equation of the radius instead of the circle equation.

In part (b), the majority of students were able to find the gradient of the radius and proceeded correctly to find the gradient of the tangent and so went on to the final answer. A considerable number made sign errors in the calculation, or mis-applied the formula for the gradient. In most cases the negative reciprocal was obtained and a correct method applied from this point, with most using the form $y - y_1 = m(x - x_1)$ as the equation of a straight line rather than $y = mx + c$. Some failed to recognise the relationship between the gradient of the tangent and radius and continued to use their original gradient for the equation of the tangent. Some used the centre of the circle in the equation of the tangent, showing lack of understanding. Attempts at differentiation were seen in order to find the gradient, many resulting in few marks, due to the differentiation needed being beyond the scope of this module. A few tried to rearrange the equation to make y the subject before differentiating but these attempts were rare .There were completely correct attempts at implicit differentiation seen but these were also rare. Some arithmetic errors were seen, especially if $y = mx + c$ was used. Many lost the final mark by not giving the equation of the line in the required form.

Question 3

In part (a) students choosing to use f(-1)=45 had far greater success than those who opted for long division. Most attempts at long division didn't achieve a quotient in the required form. Even where the correct quotient was obtained, there was then often difficulty in proceeding correctly with the remainder.

Part (b) was answered well and most students applied f(-1/2)=0 correctly. Common errors included the substitution of x=1/2 or dealing with the substitution incorrectly, resulting in $0.5A+B=0$. This was usually followed by the incorrect A=-32 and B=16. Many students were unable to solve their resulting simultaneous equations and made several attempts while others resorted to solving with a calculator, showing no working. There was little evidence of checking solutions to simultaneous equations by substitution.

Students choosing to use division of polynomials in this part of the question didn't usually obtain full marks as they mostly didn't complete the process.
The students who answered Part (b) correctly, usually managed to reach $f(x)=(2x+1)(3x^2-48)$ in part (c). Many did not continue to factorise from there.

Others divided $(3x^2-48)$ by 3, giving (x^2-16) but then didn't continue to $(x-4)(x+4)$ and/or forgot to include the factor 3 in their final factorisation. Various methods of factorisation were seen, the most popular and successful one being long division. Calculators were sometimes used but many of those responses omitted the factor 3.

The most common incorrect final answers seen were:

$f(x)=(2x+1)(3x+12)(x-4)$,

$f(x)=(2x+1)(3x-12)(x+4)$ and $f(x)=(2x+1)(x+4)(x-4)$.

Question 4

Overall, this question was quite well attempted.
Part (a) was generally tackled accurately by applying the cosine rule. A surprising number of students seemed to be reluctant to have their calculators in radian mode and preferred to work with degrees and then transfer back to radians, usually successfully.

A small minority used the 2×arcsin(3.5/8) approach, which was much easier to apply. Of those that failed to get full marks, the majority of mistakes were by an incorrect application of the cosine rule often mixing up the sides.

A sizeable minority of students started by assuming angle COD = 0.906 and substituting it into the Cosine Formula or Sine Rule to show LHS = RHS. This was not a complete proof without advanced considerations regarding approximations.
In Part (b) most students knew the formula for arc length, the majority working directly in radians. Most students also managed to find one of the missing angles on the straight line, although a few subtracted 0.906 from 2(pi) rather than pi.

Many students added both the 7 and 16 to their final answer, with only a small minority forgetting one side. There were some examples of premature approximation which resulted in answers outside the range deemed acceptable. As always, it should be emphasised to students that they should work to one figure of accuracy greater than that required in the answer. Some surprising "misunderstandings" occurred, for example assuming the radius was 7, 6 or even 4, though the lengths of the straight lines on the perimeter were kept as on the diagram.

In Part (c), the students knew that the areas of two identical sectors plus a triangle needed to be calculated. Most knew the formulae, $\frac{1}{2}r^2\theta$ and $\frac{1}{2}ab\sin\theta$, and applied them accurately, though some mixed up their use of the angles AOD and COD. Again, a small, but significant, number of students preferred to work in degrees rather than in radians. Some students used Pythagoras' Theorem to calculate the height of triangle OCD, usually correctly, and then proceeded to use $\frac{1}{2}bh$.

A small number of students who correctly identified the two correct formulae then incorrectly calculated the areas or failed to use the area of the sector twice, resulting in them losing the accuracy mark.

It must be stated that students who prematurely approximated to their answers were often in danger of not achieving the required degree of accuracy. Students should be encouraged to maintain as much accuracy as possible throughout these questions and only truncate their result at the final stage of their working to minimise such errors.

Question 5

Generally students struggled with much of the algebra in part (i) and many only obtained the first two available B marks due to their poor algebraic manipulation
Part (i) needed the formula for the sum of two terms of a geometric series and the formula for sum to infinity. Students usually gave the correct expressions. Those students who identified that the first two terms were a and ar, so used $a + ar = 34$ as their first equation were generally successful in finding r and then a. Those students who used the formula for the sum of a GP leading to $a(1 - r^2)/(1 - r) = 34$ were, more often than not, unsuccessful. Mostly they failed to factorise $1- r^2$ in order to cancel the factor of $(1 - r)$ and thus ended up with a cubic equation which they could not deal with. Substitution of 162 for $a/(1-r)$ in the S_2 formula led to a very elegant solution which a number of students spotted. Most eliminated a to find r first. This was the easier option. A few students managed to eliminate r successfully although many floundered with the algebra that followed and were unable to solve the quadratic in 'a'. Incorrect and invalid values of r, for example where $r > 1$ or $r < 0$, were frequently obtained, and then used to evaluate a. Some students found the correct values of r and a without showing any working.

In part ii) the majority of students stated and substituted values into the correct expression for the sum of n terms and gained the first method mark. A very small minority used the nth term instead, in which case no marks were available for this part of the question, as it led to a simpler but contradictory equation. Most students were obviously familiar with how to proceed with this sort of question and many scored 3 out of the 4 available marks. There were however various errors such as expanding $42(1 - (6/7)^n)$ to get $42 - 36^n$, or multiplying the 290 by 7 rather than 1/7. Where students managed to isolate $(6/7)^n$, most were able to use logs correctly to progress from this point and achieve a solution, with correct interpretation of the value of n. However the last mark was often not obtained due to inconsistent inequality work. Final statements were frequently seen such as $n < 27.9$, $n = 28$. Many failed to recognise log(6/7) as being negative and consequently lost the accuracy mark by not reversing their inequality sign after dividing. Many avoided the issue of inequality signs by using '=' throughout. They were able to gain full marks provided they stated that $n = 27.9$ prior to concluding that n must equal 28. Trial and improvement was attempted by a small number of students, usually resulting in a value of $n = 28$, but not always supported with the value of the sum when $n = 27$ for comparison to show that $n = 28$ was indeed the smallest value to satisfy the inequality.

Question 6

This was an accessible question with many fully correct responses, especially for part (a). Errors in expanding the brackets were not uncommon, but it was only a minority of students who failed to attempt the expansion. Those who did not, either made no attempt or simply tried to integrate the two terms and multiply the result, yielding results such as $5x^2\left(\frac{2}{3}x^{\frac{3}{2}} - 2x\right)$.

Of those who did expand, most did so correctly, but there were many who made errors, commonly in the first term, occasionally in the second. The result $\frac{20}{3}x^{\frac{3}{2}} - 10x^2$ was common, arising from the expansion$10x\left(x^{\frac{1}{2}} - 2\right) = 10x^{\frac{1}{2}} - 20x$.

The integration process was successfully carried out by the majority, even if with an incorrect expansion, and most simplified their answer with very few continuing with an unsimplified version.

There were a few cases of integration by parts attempted, and although generally with some success, it would be worthwhile for the students to be aware of the much more straightforward approach intended.

Some students attempted to find a value for a constant of integration in (a) by substituting in the value 4 and equating to zero. This was unnecessary and may have cost them time.

Very few students differentiated rather than integrated.

The general procedure required for find the areas using definite integrals is well known to student, but the negative area between 0 and 4 did cause problems for many. The majority of students (who attempted part (b)) managed to substitute limits of 4 and 0, and then 9 and 4. Those who obtained full marks in (a) usually went on to earn at least the first 3 marks in (b), but sign errors or failure to use the modulus of "-32" often lost the final 2 marks.

Although students realised they needed to do two separate integrals they didn't always realise why they needed to do it separately, a number of them simply adding the results of their two evaluations (so $-32 + 194 = 162$ when part (a) was correct). For those with incorrect part (a) who ended up with a positive value between 0 and 4, none seemed to realise this was in error, but those ending up with negative values did often make them positive. Some did not make any attempt to combine the values at all.
A few students tried to deal with the second area as a triangle while a small number of students attempted the Trapezium rule to answer (b). Also there were a few attempts, assumed from a calculator, where students simply wrote down the answer with no working – sometime following an incorrect part (a). The latter gained no marks as it did not follow their part (a) as per the instructions in the question.

Question 7

In Part (i) most students gained the first mark by stating $(2x+1)\log 8 = \log 24$ and then successfully rearranged to obtain the printed answer $x = 0.264$. Rearranging the equation $2x+1= 1.528...$ to make x the subject proved difficult for some students as they added 1 to both sides rather than subtracted, or they divided through by 2 before subtracting 1.

A common error was following $(2x+1)\log 8 = \log 24$ with $(2x+1) = \log (24/8)$ instead of $(2x+1) = \log 24/\log 8$.

A more unusual method seen was using $8^{2x+1} = 8^{2x} \times 8$ followed by division through by 8 before taking logs of both sides of the equation. A few students continued to change the 8 to 2^3, proceeding to 2^{6x+3} before taking logs of both sides of the equation.
The question had asked for the use of logs, so an answer with no working gained no credit here.

In Part (ii) the majority of students gained the first mark by replacing $2\log_2 y$ with $\log_2 y^2$ and, at some point in their working, using $\log_2 2$ or $2^1=2$. There was more success than in previous sessions in combining logs correctly, but difficulties arose where students created a triple fraction.

Students who rearranged the equation so that $\log_2 y^2$ was on the right hand side didn't produce the triple fraction so they tended to progress to the correct quadratic. Some checking of fraction work was in evidence and the students who did this, generally reached the correct quadratic.

Those who combined terms correctly and arrived at $2^{2.584962501...}$ almost always changed to 6 and proceeded to the correct quadratic and final solutions.
A few successful students changed $-2\log_2 y$ to $+\log_2 y^{-2}$ before collecting terms and obtaining correct solutions.

Where a quadratic in y was obtained following reasonable log work, most students were able to use a correct method to solve it. Of those who obtained the correct quadratic, almost all students used the quadratic formula to solve and find both solutions $y= 3/2$ and $y=1/3$, but some then rejected $y=1/3$, typically stating $1/3 < 3/11$ as their justification.

Question 8

This was a discriminating question, especially (ii)(a), which only very few students answered correctly . Perhaps surprisingly, among those who did manage to answer the difficult (ii)(a), many could not answer (i). However, most students did manage to make progress with (ii)(b), which seemed more familiar.

Knowledge of valid methods for changing or solving trigonometric equations was poor and appears to be a real weakness amongst a sizeable group of the students.
Part (i) was the more successfully answered of the two parts overall, though even the task of rearranging the given equation to $tan\theta =$ ...proved to be problematic for many.

Those who did arrive at $\frac{\pi}{3}$ often did not use the most direct method. However, the majority did reach $\frac{\pi}{3}$ somewhere in their solution.
The majority that succeeded used tan, with only a small number squaring the expression and using way 2 on the mark scheme. Such latter attempts often went wrong, leading to incorrect solutions as the algebra in rearranging the trigonometric expressions was not good. For example they often omitted to square root to √3. Even successful students via this method would often lose the final A for generating spurious solutions. Completely correct solutions following on from squaring were rare.

Another common method generating extra solutions was to attempt to factor out cos3θ, yielding $cos3\theta\left(tan3\theta - \sqrt{3}\right) = 0$and hence also giving solutions for cos3θ=0.
Most students, including those who had not obtained $\frac{\pi}{3}$, succeeded in adding π or 2π (usually the latter) to their previous angle. The omission of one of the solutions, due to only adding 2π to the principal angle, was common. There were a number of students that dismissed values outside the limits at the 3θ stage and failed to gain the last marks, and a significant few who did not divide by 3, usually as they had lost the 3 in their equation at an earlier stage.

Many worked in degrees but most of these were usually successful in converting to radians at the end.

In ii)a) the majority of students did use the correct identity to gain the first mark, though this was often where they stopped. However, the principle of applying $sin^2x = 1 - cos^2x$ is well known. Use of $4sin^2x = 1 - 4cos^2x$ or $4sin^2x = 4cos^2x - 4$ were common errors.

After achieving a quadratic in cos *x*, only a very small number of students went on to attempt to solve the quadratic by valid means. Those who did generally used the quadratic formula, with attempts at completing the square being very rare.
After proceeding to $4\cos^2 x - \cos x - k = 0$ many simply gave up and proceeded to part (b). Students seemed uncertain how to solve the quadratic, the most common error being to write $4cos^2\theta - cos\theta = k$ and then factorise the left hand side to $cos\theta(4cos\theta - 1) = k$and deducing $cos\theta = k$ or $cos\theta = \frac{1+k}{4}$. Another common response was to see $cos\theta = \frac{k}{4cos\theta-1}$.

For part (ii) (b) most students (including those who had correctly solved (a)) picked up from the equation$4cos^2\theta - cos\theta - k = 0$ and substituted *k*=3 and were on more familiar terms with a 3 term quadratic with numerical coefficients.

Having attained $4cos^2\theta - cos\theta - 3 = 0$ solving this equation was generally well done with just the occasional mistake with signs (resulting in values −1 and ¾ for cosθ). Most solved by factorising the equation, either directly or via an intermediate variable, though quadratic formula or solutions just written (by calculator) were also common. Those who reached $cos\theta = \frac{-3}{4}$ and $cos\theta = 1$ usually went on to earn full marks. However there were also those who tried to use their incorrect work from (a) which usually led nowhere.

Question 9

This question involved several different areas of work, area, volume, algebraic manipulation and calculus, and although a significant number of students produced clear and well-structured solutions, this proved a discriminating question for many students.

Students who had learnt the formula for the volume and surface area of a cylinder usually gained at least three marks in part (a). However with a ‘Show that’ question it is important to explain each line of the working. In far too many cases the $6\pi r^2$ appeared with no reference to the cost multiplied by area. A fully correct solution also required the students to segregate the surface area from the Cost. Far too many erroneously just replaced the ‘SA’ with ‘C’ or ‘Cost’ thus forfeiting the last mark. Around 5% of the students misread the volume as 75 instead of 75π. They lost at most one accuracy mark in (a) but many recovered in (b) and used the correct form of C given in the question. A number of students left this section blank. The final line often appeared after several attempts and much crossing out and errors. Common errors included incorrect formulae, no obvious method, missing π and no mention of Cost = in the final answer.

In part (b) many students correctly differentiated C and dealt with the negative power of x successfully. A large proportion also then set their expression equal to zero and found $r =$ …. There was some very poor algebraic manipulation, particularly the negative power, and the correct value of r and C were achieved by only half of the students. A number who found the correct value for r failed to calculate the value of C.

If students successfully tackled Part (b) then they generally knew that for part (c) they should calculate C'' and check that it was positive, to ascertain that C was in fact minimised with their value of r. Having calculated C' accurately, most found the correct expression for C''.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
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