Examiners' Report

Summer 2015

Pearson Edexcel GCE in Core Mathematics C3 (6665/01)

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General Introduction

The Core 3 paper was accessible to a wide range of students. Timing did not seem an issue as there were very few scripts where question 9 remained blank. Questions 2, 3, 4 and 6 were familiar to students and provided a welcome source of marks. Question 1, 5, 7, 8 and 9 were more discriminating but presented opportunities for the better students to show their skills. Points raised from this examination that could be addressed by schools in future were: students need to be more careful in sketching graphs, with care needed at the asymptotes. Any intersections with axes should be calculated. Bracketing, or indeed lack of bracketing is still causing problems. This was particularly evident in questions 5, 6, 7 and 9. Also, students would be well advised to quote the product rule or the quotient rule, before stating their u, u', v and v'. This was apparent in questions 7 and 9. Finally, although the quality of answers seen to proof questions has risen over the past few years, many students still need to provide examiners with intermediate steps to show a full appreciation of what is required.

Report on Individual Questions

Question 1

This question proved to be a challenging start for many students, with part (b) causing problems. However, the question was attempted by nearly all students. The majority of students were successful with part (a), although there were occasional sign errors in the double angle formula, usually when attempting to expand tan(θ + θ) rather than using the formula for tan 2*θ*. A small number of students just wrote tan 2*θ* = 2*p*, while another commonly seen error was the error in the denominator $\frac{2tan\theta}{1-2tan\theta} = 2\frac{p}{1-2p}$.

Also, there were a few instances of simply replacing *θ* by *p* and not attempting an expansion at all.

Part (b) caused problems due to the fact that two identities were required to establish an equation purely in cos *θ* and tan *θ* . Many responses only went as far as $cos\theta = \frac{sin\theta}{p}$, with no attempt to replace sin *θ*, either due to not realising the need to do so, or not knowing how. However, a very few did proceed from here squaring both sides then using $\sin^2 \theta = 1 - \cos^2 \theta$ and rearranging to achieve the correct solution. Those who wrote cos *θ* as $\frac{1}{\sec\theta}$ or sec *θ* as $\frac{1}{cos\theta}$ generally then realised the need to deploy $\sec^2\theta = 1 + \tan^2\theta$ and usually scored both marks. Those who knew the Pythagorean triangle method for establishing trigonometric values/had more success, though this useful technique seems not to be known by many students.

In contrast to part (b), part (c) was answered well by many though a full range in the quality of responses was seen. Most knew that cot(θ – 45º) had to be written as $\frac{1}{\tan(\theta-45^o)}$,

but whilst the majority used the correct formula for tan(*A* − *B*), deployment the compound angle formula was the more problematic part of the question. A sign error in the denominator of the tan expansion was the most profligate error, while it was also common to see use of tan(*θ* – 45º) = tan *θ* – tan 45º = *p* − 1 or even cot(θ – 45º) = cot θ – cot 45º.

Question 2

(a) It was pleasing to see that almost all students knew the shape of an exponential graph and the effect of the modulus, and were able to sketch both reasonably well.
(i) Having said this, a significant number of students had graphs in part (i) which appeared to have a vertical asymptote in the first quadrant and/or a local minimum point, as, opposed to asymptotic behaviour, in the third quadrant. Students should be advised that, when sketching a graph, care needs to be taken to ensure that a slip of the pen does not result in an incorrect sketch.

Common mistakes in part (i) included the labelling of the y intercept as -4 or the asymptote as y= -4 and, less commonly, labelling the asymptote as x=-5. A few students had the y intersection as (0,-3) alongside y = -3 as the equation of the asymptote. The intersection on the x-axis was often given correctly in its exact or decimal form, indicating students were comfortable with solving f(x) = 0, although quite a number of students made no attempt to identify this intersection.

Students showed that their understanding was less than clear when it came to stating the equation of the asymptote It seemed that many did not fully grasp the concept of an asymptote as a line with its own equation, so that instead of y = -5, such students sometimes wrote $y>-5$ or $y\neq5$.

(ii) The modulus function and its effect when applied to a graph was seen to be well understood and almost always a cusp was visible with hardly any students guilty of 'rounding' the cusp. A significant proportion of those students who did draw and or label an asymptote in part (i) failed to do so in part (ii). Occasionally a dotted line was seen which stopped at the y-axis, suggesting further evidence of confused understanding with regard to asymptotes.

(b) A clear majority of students failed to answer this part correctly. Many stated x=ln(5/2) or their decimal equivalent from earlier. The question involved an equation, and it seems that students only gave one answer because of this, despite the indication in the question that “a set of values” was called for. Of those who did realise that an inequality was required, some lost the mark because they stated a strict inequality.

(c) The majority of students found at least one solution in this part of the question, with x=ln(7/2) being the more common. Many students, if not the majority, were also able to solve for the other root. There were only a few students who found answers to this part in a non-exact decimal form.

A few students chose a harder method of solving which involved squaring to deal with the modulus function. Students who chose to deal separately with the two cases f(x) = 2 and f(x) = −2, found the working much easier and were more likely to get the correct answers.

Question 3

This question was generally well answered, with many gaining full marks on parts (a) and (b). In part (a) nearly all students achieved the full three marks. Those did lose marks tended to do so because they had not found the exact value of R, instead rounding to one or two decimal places. A few students rounded α to 1.d.p. instead of the required 2.d.p. Radians were rarely seen.

Many students were successful in solving to get the two correct values within the given range. A small proportion of students stopped when they had one solution and gained only 3/5 marks. Indeed some students showed a lack of understanding with +51.8 being followed incorrectly by -51.8 .

Students had more difficulty with part (c) of the question and many did not attempt it. Some realised that it was connected to √20 but were unable to identify the region accurately. Some simply gave the interval as k>1 or k<-1. -√20<k<√20 was also a common error. Students who identified the correct range sometimes went on to express it incorrectly as √20<k<-√20.

Question 4

This was a largely accessible question to all students, with the majority scoring at least 6 out of 7, with the lost mark being due to an incorrect form for λ. The standard of logarithm work seems to have improved over previous years.
It was rare (<5% estimated) to see a wrong answer to part (a) although 120 (arising from $e^0 = 0$) and 100 (taking the coefficient of the exponential term) were both occasionally seen.

In part (b), the majority of students got to $e^{-40\lambda} = A$ and most proceeded to correctly deal with the exponential by taking natural logarithms. Most were able to achieve a correct *value* for λ. However, one of the most common errors seen across the entire paper was the failure to obtain λ in the stated form, with usually $\lambda = \frac{ln0.5}{-40}$ or $\lambda = -\frac{ln(1/2)}{40}$

being given as the answer. Those sharp enough to manipulate $e^{-40\lambda} = 50$ into $e^{40\lambda} = 2$ rarely failed to score all four marks, while more able students arriving at

$\lambda = \frac{ln0.5}{-40}$ confidently rearranged their expression using $ln0.5 = ln2^{-1} = -ln2$ or

$ln\left(\frac{1}{2}\right) = ln1 - ln2 = -ln2$ to achieve the integer form. A small number attempted to take logarithms at the $100e^{-40\lambda} = 50$ stage. Those so doing seldom made much progress and so usually scored no marks, though a few taking this approach did deploy correct laws of logarithms to reach the required answer.

Students comfortable with logarithms usually made light work of part (c), but a number of students became confused at the $ln\left(e^{\frac{-ln2}{40}T}\right) = ln0.2$ stage. Some avoided any mishap by keeping this equation in λ and T. Sign errors were the most common error on this part, often producing a swiftly (or secretly) corrected answer of −93 with students clearly at least appreciating the time should be a positive quantity.

A few unrealistic final answers were evident, including a few with a value of T so large that standard form had to be used. It would benefit students to appreciate that contextualised questions in mathematics are almost always realistic, so a final check on the plausibility of a final answer is good practice.

Question 5

Question 5 certainly demanded more of students but it was pleasing to see a large number of well-presented, elegant solutions as compared with the responses to a similar (although somewhat more difficult) question on the June 2014 paper. There were only a very few cases of students not attempting (b).

The mark in part (a) was achieved by most, with correct substitution for y, although some students failed to evaluate the sin π giving $(2\pi - \sin\pi)^2$, or gave p only as a decimal. Other common errors were to give $2\pi^2$ in place of $(2\pi)^2$ or simply 2π.
Part (b) was also generally well answered, with the method marks being picked up by many, though fully correct solutions were only given by a minority. The procedure required for the question was well understood, but errors in algebra, either in substituting the value of y into the derivative, or in rearranging the final equation often cost students the final mark. Almost all students realised the need for differentiation, but a few tamely substituted x = 0 (or y= 0) into the equation of the curve.

The differentiation was generally well done in this part, with a good recognition of the interplay between $\frac{dx}{dy}$ and $\frac{dy}{dx}$ being shown. The most successful attempts used the chain rule to find $\frac{dx}{dy}$ with only a lack of bracketing leading to incorrect answers. Other common wrong answers via this method were to miss out the 2 in the $(4 – 2\cos2y)$ bracket, lose the multiplier of 2 (giving $\frac{dx}{dy} = (4y - sin2y) \times (4 - 2cos2y)$or indeed give $\frac{dx}{dy} = 2 \times (4y - sin2y) \times 4 \times 2cos2y$ Other students multiplied out the brackets before differentiating, using the product rule as necessary. This was usually well done, but generally there was more scope for errors with this method. The following three method marks were accessed by a great many of the students although students would be advised to show their method clearly. The need to invert $\frac{dx}{dy}$ before or after substitution was appreciated by most students reaching this point, however, and so many did go on to find an equation for the tangent. The method for finding a straight line is well known, and use of $y – y_1 = m(x – x_1)$ was used more frequently than $y = mx + c$ and going on to find c. The final method was gained by the vast majority, though a few did attempt the point where it cut the *x*-axis instead of the *y*-axis. Usually this was solved by substituting x=0 into the equation, though a small proportion of students, usually the better ones, did rearrange to $y = mx + c$ and read off the intercept.

Question 6

For the vast majority of students, this question was very accessible with a significant number scoring well, and many produced fully correct solutions. It was noticeable, however, that many students lost marks unnecessarily by not showing their full working.

In part (a) virtually all students equated the two equations and proceeded to score the first M mark. However, some then took logs of each term rather than of both sides. Students who took logs of base 2 were usually successful in progressing to the given answer. Students tended to lose the A mark for lack of bracketing in most cases around the (x+1) term when writing this in front of ln2, or occasionally for the lack of brackets for ln(20-x). Some students showed very few stages of working or what appeared to be working from both the start and the end but not showing the crucial taking logs of both sides and/or bringing the power to the front.

In part (b) a large majority of students scored full marks. It was clear that students knew how to tackle iterative problems and usually rounded to the correct answer. There was however a small number of students who omitted the “-1” from their iterative formula.

Most students scored both marks in part (c). However, it was not uncommon for students to just find the *x*-coordinate. The A mark was lost by students for either not rounding their answers to the required degree of accuracy, or by using an inaccurate value for *x* which resulted in an incorrect *y*-coordinate.

Question 7

Whilst a pleasing proportion of students dealt successfully with part (a) of this question, less able students tended to struggle with the differentiation. Those who used the product rule with $u = x^2 - x^3$ and $v = e^{-2x}$ or the quotient rule with $v = e^{2x}$ were most successful in differentiating and reaching the correct three term cubic for f(x). Some students chose to write $u = x^2e^{-2x}$ and $v = (1 – x)$ or $u = x^2(1-x)$ and $v = e^{-2x}$ and attempted to use the product rule twice. Only a few of those who chose this route went on to get the correct f(x). Those students who multiplied the expression out and differentiated two terms, tended to be more successful although accuracy was often lost thanks to a failure to bracket the second of the derivatives. Other methods seen were applying implicit differentiation to $ye^{2x} = x^2 - x^3$ and also some who applied the product rule for uvw .

The range of responses to this question highlights the need for students to look for the most efficient way of expressing their function before attempting to differentiate.
Part (b) The marks for setting their f(x) = 0 and factorising to get x = ½ and x = 2 were easily earned by those who were successful in part (a), and many fully correct solutions

for the range were seen. Some students stopped after reaching their *x* values and did not substitute to get *y* values. The final accuracy mark was lost by those who gave decimal as opposed to exact values in their statement of range. A few students used < rather than ≤ symbols in their statement of range and thus lost an accuracy mark. Others lost a mark as a result of stating their range in terms of x rather than g(x).

Only a minority of students gave a clear and complete answer to part (c) of the question. Amongst unacceptable answers offered by students were - you cannot find the logarithm of a negative number; *x* cannot be negative; *x* cannot be made the subject of the formula; e^{-2x} does not have an inverse; g(x) is a one to many function

Question 8

Part (a) saw many long attempts at a solution with many trig identities used and tan 2A being re-written in many different forms. Most students managed to convert the LHS to a single fraction in sine and cosine of a single angle, gaining the first 3 marks. Very few thought of replacing 1 in their numerator with the Pythagorean identity to achieve a perfect square trinomial in sine and cosine which would enable factorisation and then cancellation to the required result. Lots of students had different forms of the double angle as denominator which made further progress even more difficult.

Students usually used the answer to part (a) in part (b) and there were plenty of accurate solutions seen. Of those who got as far as $\tan\theta = -1/3$, they usually went on to solve correctly for full marks.

It was surprising to see a fair number of mistakes in the re-arranging of the equation to get $\tan\theta = k$ because of poor algebra. There were only few students who chose an alternative route. It is disappointing to see students at this level getting as far as $\cos\theta = -3\sin\theta$ and then choosing to square both sides to proceed further thus introducing extra solutions.

Question 9

Most students were able to make a good attempt at this question, although very few achieved full marks. Many students treated the ‘k’ like a variable and differentiated it to 1.

In part (a), students who did not factorise and cancel before combining the two fractions found the numerator difficult to simplify. The weaker students made errors when simplifying, usually due to sign errors when dealing with the subtraction of the second bracket. Those who achieved x^2-k^2 as their numerator were usually successful in spotting this was the difference of two squares and proceeded to the given answer correctly.

Most students differentiated successfully in part (b), with the quotient rule the most popular method. Those who quoted the formula were able to score the method mark, even if they had problems differentiating the terms correctly. There was a small number who confused f'(x) with $f^{-1}(x)$.

Part (c) was poorly answered. The idea of a derivative being a rate of change and linking to increasing/decreasing functions seemed unfamiliar to many. A large number of students achieved an acceptable answer from (b) to work with but concluded that f(x) was decreasing because k was negative. Very few identified the required method linking the idea of increasing/decreasing functions to f'(x). Indeed many attempted to find f''(x) believing that this would help.

Grade Boundaries

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