Examiners’ Report

Summer 2014

Pearson Edexcel GCE in Core Mathematics 3 (6665/01)

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General Introduction

This paper was found to be accessible by most students sitting the paper. It contained a mixture of straightforward questions that tested the student's ability to perform routine tasks, as well as some more challenging and unstructured questions that tested the most able students.

Overall the level of algebra was pleasing, although there were many examples of students not using brackets correctly.

When an answer is given it is important to show all stages of the calculation. It is also useful to quote a formula before using it. Examples of this are when using the product rule (Q3) and quotient rules (Q1 and 8c) in differentiation.

Report on Individual Questions

Question 1

Q01(a) was generally done well. Most students used the Quotient Rule and were successful; the main errors that occurred were from bracketing mistakes. Students who did go wrong tended to write

$$\frac{4x-8-x+1}{(x-2)^2}$$

Some of these were able to recover, helped by working towards the given answer but still losing an accuracy mark. A few used the Product Rule and even fewer used the Chain Rule. A minority of students found the inverse of $\mathrm{f}(x)$ rather than its derivative.

In Q01(b) nearly all students were able to gain full marks here. Having equated the expression given in Q01(a) to -1, the majority of students multiplied out and solved a quadratic equation rather than adopting the shorter route of taking the square root of both sides. Having said this, almost everyone obtained the right quadratic equation and went on to find the correct coordinates. A few students did not find the y coordinate; many found the coordinates of two points (5,7) and (-1, 1), not noticing the domain $x > 2$. (Failure to reject the additional point was not penalised.)

Question 2

Q02(a) was completed well with the majority of students able to reach the answer in its simplest form. The method of rearranging to $\ln(2x+1)=5$ was the most popular and usually successful. Those who used the power law often lost the second mark because they left the answer in terms of $\sqrt{(\mathrm{e}^{10})}$. Some students who used the power law correctly to give $\text{in}(2x+1)^2 = 10$, then proceeded to take the square root of both sides to give $\text{in}(2x+1) = \sqrt{}10$. A minority of students attempted to expand $(2x+1)^2$ which almost always led to no further progress being made.

Q02(b) was more challenging with the main issue being students failing to recognise that the LHS comprised of two functions multiplied together, and hence they did not apply the addition law. Expressions similar to $\ln 3^x x\ 4x = 7$ were commonly seen. Those who moved $4x$ to the RHS and then took in usually fared much better. Of those who did achieve the first two marks only a minority did not know how to collect terms and factorise to arrive at the correct answer.

Question 3

The mark in Q03(a) was scored by the vast majority of students, with only very occasional signs of students not knowing what to do. To verify that 'P lies on C', they had to substitute $y=\frac{\pi}{8}$ into the equation. A very few substituted π instead, or else there were occasional incorrect statements given due to confusion in simplifying, such as $x=8\frac{\pi}{8}\tan\left(2\frac{\pi}{8}\right)=\pi\tan(\pi)=\pi$.

For Q03(b) most students demonstrated good knowledge of trigonometric differentiation and applying the product and chain rules to find $\frac{dx}{dy}$ scoring the first three marks.

Of the students who failed to score these, the most common errors were:

- Omitting the y in the y term giving $8\tan 2y+16\sec^2 2y$,
- Losing the 2 in one or other of the arguments in the expression, usually again the $\sec^2 2y$ term, so having, $8\tan 2y+16\sec^2 y$
- Failing to use the product rule at all, and getting just on its own $16y\sec^2 2y$ (or occasionally other single term expressions).

It was extremely rare to see any attempt to make y the subject of the formula before differentiation.
It was at this point of the question, after find the correct derivative, that errors were most often made. Knowledge of finding a "numerical" value of $\frac{dx}{dy}$ or $\frac{dy}{dx}$ and then an equation of a tangent at a particular point was good but the execution was poor.
The majority of students proceeded to try and find an expression for $\frac{dy}{dx}$ before attempting to evaluate, and in so doing often made errors. The most common error seen was incorrectly split fractions:

$$\frac{dy}{dx}=\frac{1}{8\tan 2y+16y\sec^2 2y}=\frac{1}{8\tan 2y}+\frac{1}{16y\sec^2 2y}$$

If not incorrectly split at this point, writing $\frac{1}{4\pi+8}=\frac{1}{4\pi}+\frac{1}{8}$ at a later point was also common.

Once a numerical value of $\frac{dy}{dx}$ had been found many students knew the form of the tangent with a minority using a negative or negative reciprocal for the gradient.

The rearrangement of the equation of the gradient resulted in a variety of errors due to the mixing of π and fractions. Students lost the final mark through inaccuracy in algebraic simplification or not giving the equation in the required form $ay=x+b$

Question 4

This question proved to be accessible to most students and a large proportion found Q04(a) and Q04(b) accessible.
Q04(c) was more testing and only more knowledgeable students scored the marks in this part.

Q04(a) was generally well done with the majority of students drawing a W in the correct quadrants. A few failed to have the left arm actually crossing the y axis. In the majority of cases the points corresponding to P and Q were labelled correctly, although a few had (6,-1) instead of (6,1) for the point corresponding to Q.

Q04(b) proved to be more of a problem for some students, due to two transformations, although a high proportion still scored full marks. Most managed to draw a V in the correct quadrants although a few did not have the right arm passing through the y axis. Some students had trouble finding the correct y intercept with (0,28) being a common incorrect answer. The minimum point was more often correct although some did label it (6,1) rather than (-6,1).

Allowances were made for those students who mistakenly sketched either $y = -2\mathrm{f}\left(x\right) + 3$ or $y = -2\mathrm{f}\left(-x\right) + 3$. Such students were allowed to score just one of the three marks. The number of students who did this was quite small.

Many students did not attempt Q04(c). Of those who did attempt it, many achieved $b = 6$ but only a few successfully reached $a = 2$. Often students got as far as $ab = \pm 12$ but were unable to proceed any further.

Question 5

Q05(a) was well tackled with the vast majority scoring full marks. Most students started by successfully factorising the quadratic $x^2 + x - 6$ and proceeded to produce a single fraction with a quadratic numerator and denominator. Most were able to correctly perform the second factorisation and correctly cancel.

Students who started by using a cubic common denominator were much more likely to fail. Whilst the technique was correct they found it difficult to progress. Occasionally a step, such as failing to simplify the expression $x^2 - 2x + 6x + 3$ before factorising, was omitted from the proof which resulted in the loss of the final A mark. In a proof it is vital to show all steps.

Students found Q05(b) one of the most challenging parts of the paper and there were very few fully correct answers seen. A few students had a reliable method for finding the range. Methods usually involved substituting numbers from the domain with no real purpose. Many students were able to identify 4 as a limit but many wrote $y > 4$ instead of $y < 4$. Relatively few students were able to obtain the lower limit. The notation for the range was usually correct with either y or $\mathrm{g}(x)$ used.

Q05(c) was well answered although not by the expected route. The majority of the students failed to spot that the intersection between a function and its inverse is always when $y = x$, therefore they went for the longer method using the inverse function. Virtually every student attempted to find $\mathrm{g}^{-1}(x)$, most successfully. They equated their answer to $\mathrm{g}(x)$ and obtained a quadratic which they solved, usually by correct use of the quadratic formula. A small, but significant number did not appreciate the meaning of exact and solved the final quadratic giving only decimal answers and some stopped having gained the correct quadratic, perhaps expecting it to factorise. Errors in manipulation and signs occasionally led to an incorrect 3TQ, but most students were able to gain full marks. A few students mistakenly equated $\mathrm{g}(x)$ to its reciprocal or to $\mathrm{g}'(x)$. Although they did not have to for full marks, very few justified their choice of $\frac{3+\sqrt{13}}{2}$, rejecting $\frac{3-\sqrt{13}}{2}$.

Question 6

This question was generally answered very well with many fully correct responses.

Q06(a) was successfully answered by most of the students, although some worked in degrees and were unable to understand why there was no change in sign. Partial credit was given to such a solution.

Q06(b) was the one part where marks were most often lost, though the majority of students gained at least some marks. Where marks were lost, it was largely due to one of three reasons:

- Failure to differentiate at all. There were a small by significant number of attempts to rearrange the original equation into the one required, usually involving an attempt to replace $\cos^2\left(\frac{1}{2}x\right)$ by $1-\sin^2\left(\frac{1}{2}x\right)$.
- Incorrect differentiation. Again a fairly common error to make, and either an incorrect sign or missing the "x" in front of the sine term to blame. Students who differentiated at least obtained the $3x^2-3$ terms.
- Failure to explicitly set the derivative to 0 at any stage. There were a number of students who failed to make an explicit statement involving "$=0$" somewhere in the solution. This error lost the final two marks of this part for the students.

Q06(c) was well answered with the majority of students gaining both marks here. The overriding common error was use of degrees, not radians, and strangely, this often even followed correct use of radians in Q06(a), an anomaly that is difficult to account for.

Question 7

Q07(a) was found to be demanding. Those who started by using $\frac{1}{\sin 2x}+\frac{\cos 2x}{\sin 2x}$ and then combining to form a single fraction, were able to progress and generally went onto to achieve full marks. Students who used the double angle formula for tan before combining their fractions generally found it difficult to deal with the resulting algebra and failed to achieve more than the first mark or two.

In Q07(b) most students recognised the link with Q07(a) and successfully found two solutions. Common errors were $2\theta+10$ instead of $2\theta+5$ and using $\tan 60$ instead of $\tan 30$. There were a small number of students who attempted to use the tan addition formulae, but most gave up after only a couple of lines. The statement about '*solutions based entirely on graphical or numerical methods not being accepted*' was clearly heeded, as solutions without working were rarely seen.

Question 8

Q08(a) was nearly always correct, and mostly just written down. For the ones who did make errors, they might be better advised to write down an intermediate line on two mark questions.

Q08(b) highlighted some weaknesses in solving exponential equations. Most students knew that they had to reach a form $e^{0.1t}=A$ before taking lns but there was a sizeable minority who insisted on taking lns early resulting in few, if any marks. Most students knew the meaning of the word integer and wrote their answer in an appropriate form but there were lots of cases where $0.1t=\ln 5 \rightarrow t=0.1\ln 5$

Q08(c) was seen to be challenging. A statement of the quotient rule would have helped many students. Quite often $e^{0.1t}$ was differentiated to $0.1te^{0.1t}$ or $t=10$ was substituted in first producing a constant, which was then differentiated. A lot of fully correct answers were seen however.

Q08(d) was seen to be one of the most challenging questions on the paper. Incorrect answers such as 'time cannot be negative' through to 'they cannot get bigger than 200' were frequently seen. The most fruitful method involved substituting in $P=270$ and showing that t cannot be found by referring to the sign of either ln or exp.

Question 9

The large majority of students answered Q09(a) correctly, but Q09(b) and Q09(c) proved to be more challenging.

For Q09(a) most students scored all three marks. Almost everyone found the value of R correctly. When finding the angle, the most common errors involved either using degrees instead of radians or writing $\tan\alpha = \frac{1}{2}$.

In Q09(b)(i) a good proportion of the students achieved 104 for the maximum value, although some failed to square the value of R and gave the maximum as $4 + 5\sqrt{20}$.

In Q09(b)(ii) many realised that an angle of $\frac{\pi}{2}$ was required, however it was very common to see $\theta - \alpha = \frac{\pi}{2}$ instead of $3\theta - \alpha = \frac{\pi}{2}$.

In Q09(c)(i) an answer of 104 was seen for the minimum value as well as the maximum, as students set the trigonometric expression to -1 instead of 0. A minimum value of -104 was also seen quite frequently. Few seemed to realise that setting the bracket =0 solved the problem.

In Q09(c)(ii) the correct answer was rarely achieved. Some students scored a method mark for $3\theta - \alpha = 0$ or π instead of 2π.

A significant minority of students attempted to use calculus in Q09(b) and Q09(c). Such methods could achieve all of the marks but students choosing this route were rarely totally successful.

Grade Boundaries

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