Examiner's Report
Principal Examiner Feedback

October 2019

Pearson Edexcel International A Level
In Core Mathematics C34 (WMA02/01)

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October 2019
Publications Code: WMA02_01_1910_ER

General

The November 2019 C34 paper had an interesting mix of fairly routine questions interspersed with ones that really tested the candidate's ability to think within an examination situation. Unlike earlier examinations of this series, many of the early questions had aspects to them that tested even higher performing students. On the whole, candidates seemed to have been very well prepared for this examination. Many questions were well answered with questions 1, 2, 5, 6, 8, 10, 11b, 12cd, 13 and 14b providing most discrimination. Algebraic notation was good and there were fewer occurrences where candidates had used their calculators to produce answers to questions that required full methods. Candidates do need to be more careful in writing out proofs. See the relevant points made on questions 4a, 6a and 12c. Timing did not seem to be an issue as there were very few instances where question 14 was left completely blank.

Question 1

In part **(a)** most candidates gained 3 marks for finding $R = \sqrt{10}$ and $\alpha = 0.322$. Where errors were made it was for finding $\arctan 3$ or $\arctan\left(-\frac{1}{3}\right)$ rather than $\arctan\frac{1}{3}$. Pleasingly only a small number of candidates worked in degrees or gave the decimal value of *R*.

Part **(b)** was far more demanding and many only achieved the first mark for $\theta_{\min} = 19 - \sqrt{10}$

The marks for achieving the value of *t* discriminated well with many failing to link the equation of the given model to their solution to part (a).Common incorrect starting points were $\frac{\pi t}{12} + 4 - 0.322 = -\frac{\pi}{2}$, $\frac{\pi t}{12} - 0.322 = \frac{3\pi}{2}$ and $\frac{\pi t}{12} + 4 - 0.322 = 2\pi$

Question 2

Part **(a)** was generally well answered, although factorising out $\left(\frac{1}{3}\right)^{-2}$ proved problematic for many candidates. This often led to 1/9 in front of the brackets or $1 - \frac{1}{3}x$ inside the brackets. Some other candidates incorrectly used $-x$, $3x$, or $x/3$ instead of $-3x$ as the algebraic term inside their bracket. However, those candidates who showed the binomial expansion fully were ensured of scoring the method mark even if their final expression was incorrect.

Part **(b)** was also generally well attempted, with many candidates expanding and gathering terms correctly using their coefficients from part (a). Most of these then went on to find values of *a* and *b*.

For those attempting this part, it was rare to see candidates using an incorrect method to find equations in *a* and *b*.

In part **(c)** almost all candidates substituted the values of *a* and *b* into their coefficient of x^3 with only a small minority leaving the answer as $135x^2$ rather than the 135 as required. There were some responses which achieved '135', with correct working in this part of the question, but following an incorrect expansion in part (a) and incorrect values of *a* and *b*. This part required a correct solution and thus, these candidates, lost the final accuracy mark.

Question 3

Very few students earned full marks for this question as many lost the first mark.

In part **(a)** a common error was to give the range as $g(x) > -1$. However, many students left this part blank and many more gave a range in x rather than y.
Many students however were successful in part **(b)**. Some having successfully found fg(x) then went on to show very little understanding of algebraic techniques in their attempt to simplify. For example, some reached the correct $\frac{10x^2-3}{2x^2-4}$ but then incorrectly cancelled out the x^2 or the 2's. In this instance, this was not penalised and "ISW", ignore subsequent working was applied, but this may not always be the case!
Part **(c)** was answered well by candidates with most being able to apply the correct method, but there were occasional slips with bracketing or with signs. A serious error was in misinterpreting
$f^{-1}(x)$ as either $\frac{1}{f(x)}$ or as $f'(x)$, the derivative of $f(x)$.
In almost all cases where the student attempted part **(d)**, the process was understood and the two method marks were gained. Many students were successful and reached the correct solutions for x. Most used their calculators to solve the quadratic equation, though a sizeable group used the quadratic formula. It was extremely rare for a student to give the decimal approximations for the final solutions.

Question 4

This was a good source of marks for good candidates who frequently scored full marks.

In part **(a)** the application of the product rule was well known. Mistakes usually occurred when differentiating $\cos 2x$ where an incorrect sign was introduced or the 2 was lost. The next part of the process, the proof, was not well done by a large number of candidates. There seemed to be a great deal of misunderstanding of $\arctan\left(\frac{1}{2x}\right)$, with many thinking that it was $\frac{1}{\tan 2x}$, $\cot\left(\frac{1}{2x}\right)$ or other similar incorrect functions. As a result, the correct final line was required to be immediately preceded by either $\tan 2x = \frac{1}{2x}$ or $2x \tan 2x = 1$ to ensure the accurate interpretation.

Part (b) was done well, even for those candidates who got confused in part (a). A common error however was to use the calculator in degree mode or interpret $\arctan\left(\frac{1}{2x}\right)$ as $\frac{1}{\tan 2x}$.

Question 5

This proved to be quite a discriminating question

In part **(a)** a surprising number of candidates did not recognise that they had to separate the variables and hence achieved no marks. Of those who did, the majority managed to get to the stage

$\alpha h^{-\frac{1}{2}} = \beta t^{-1}$. Errors were seen on the coefficients where quite often $\int \frac{1}{5t^2}\,\mathrm{d}t$ became $\int 5t^{-2}\,\mathrm{d}t$.

At the point where $\alpha h^{-\frac{1}{2}} = \beta t^{-1}$ was reached, many then missed calculating the coefficient of integration and were therefore unable to progress any further. Errors were also seen when attempting to move from $\alpha h^{-\frac{1}{2}} = \beta t^{-1} + c \to h = ..$ Having said this there were some very elegant and well written solutions providing evidence of a very good candidate.

Not surprising, correct answers to part **(b)** were rare. Those who did manage part (a) struggled with the concept and 25 and $t \neq -\frac{1}{4}$ were common incorrect responses.

Question 6

Part **(a)** was accessible to many students with most being able to gain at least one mark for attempting to combine the two given fractions. Too many solutions however made huge leaps in an attempt to prove the given identity. It is very important for candidates to show all necessary lines in a proof (see mark-scheme) and not assume that, for instance, $\frac{2\sec^2 x}{\tan^2 x}$ can be written as $2\mathrm{cosec}^2 x$ without sight of an intermediate line.

In part (b) the majority of students could use the result from part (a) to adapt the given equation. Most were able to proceed to find an equation in a single trigonometric function, usually $\tan 2\theta$ or $\sin 2\theta$. Completely correct solutions were rare however, with many good solutions scoring 5 out of the 6 marks available as accuracy was lost in an attempt to reach all four solutions. The main cause of this being the failure to consider the negative value when taking a square root.

Question 7

This was a very accessible question and as a result most students scored high marks.

Part **(a)** was nearly always correct. Errors were rare and arose from either slips in calculations leading to incorrect values of A, B and C or more commonly from an incorrect starting point usually $2x^2 - 3 = A(1-x)(1-x)^2 + B(3-2x)(1-x)^2 + C(3-2x)(1-x)$.

Most candidates were also able to score some marks in part (b). The majority realised that lns were involved and so the first M mark was usually achieved. However, there was a loss of accuracy marks with a failure to divide the coefficients A and B by -2 and -1 respectively. It was also quite common to see lns used when integrating the $\frac{-1}{(1-x)^2}$ term. Having said this 3 out of 4 marks was common here.

Question 8

In part **(a)** candidates were very good at writing down at least two of the equations with almost all going on to solve for both μ and λ. Some candidates only found one value and then the point of intersection. The B mark was not awarded very often because although a numerical calculation involving the third equation was seen it was not followed by a conclusion. It was disappointing to see that a sizeable number of candidates did not fully complete this part of the question, for having found μ and λ, they did not go on to find the point of intersection.
Part **(b)** was nearly always correct although $p = 3$ was a common incorrect answer.
Part **(c)** was either very well done or went nowhere quickly. Many candidates did not even try to answer this part. The scalar product was often applied between a direction vector and a position vector. *PQ* was generally well attempted, but candidates didn't often know what to do from this point on. Those who drew a diagram were more successful. Some candidates stopped once a value for μ had been achieved. The majority of candidates approached this part from the method shown on the main mark scheme but there was some equally good approached via *AQ*. *PQ* = 0. If μ was found correctly then the main error was to replace it in the expression for *PQ*,

Question 9

Part **(a)** of this question required candidates to sketch on different axes the graphs of two linear functions involving modulii. It was surprising to see how many errors were made in producing sketches of these graphs. In part (a)(i) the graph was frequently inverted; in part (a)(ii) both horizontal V shapes and W shapes were seen. This part proved to be more demanding than (b)

It was rare to see the dotted graphs of the original functions shown before the modulii were taken.

In part **(b),** a common approach was to use ± for every modulus function thus obtaining not only the two required equations but also two spurious ones leading to four solutions, only two of which were valid. It was rare to see the correct two solutions chosen from the four presented. This suggested that candidates did not see any link between the two parts of the question: the explicit statement that $x > 0$ for the intersections by looking at the graphs was rarely seen. Incorrect modulus work such as $|3x - 2a| = 3|x| - 2|a|$ was seen quite often.

Question 10

In part **(a)** almost all candidates scored the B mark for differentiating u=2x-1. Most also made an attempt at a complete substitution but many candidates had difficulty in reaching the required form in u before integrating the expression. As a result only the best candidates were able to make real progress here. The M mark for correct use of limits was available to most and many achieved did achieve this. It is vitally important that candidates show this step fully and not write, as a sizeable number did, $\frac{1}{8}\left[\frac{9u^2}{2} + 42u + 49\ln u\right]_3^9 = 72 + \frac{49}{8}\ln 3$. This was a given result and all relevant lines **must** be shown to score all marks.

In part **(b)** there were many correct responses. Errors were made when candidates used an incorrect formula, using 2π, rather than π or more frequently by failing to square the 2 (in the denominator).

Question 11

There was a huge contrast between part (a), where most candidates gained all of the marks, and part (b) where many marks were lost by making the wrong decision at the outset

In part **(a)** a score of 4 out of 4 was very common. The most common errors seen were:

- applying Chain Rule: $y^3 \to 3y^2$ or $y^2\,\mathrm{d}y/\mathrm{d}x$ were often seen
- applying Product Rule: $kxy \to kx + ky\,\mathrm{d}y/\mathrm{d}x$ or similar
- occasional errors in algebra when rearranging to $\mathrm{d}y/\mathrm{d}x = ...$

In part **(b)** the main error was caused by setting either $\mathrm{d}y/\mathrm{d}x = 0$ or $\mathrm{d}y/\mathrm{d}x = 1$. Candidates using the first of these were able to gain two of the three method marks, as it was considered they were at least attempting to find a line parallel to one of the axes. Students who did realise that they needed to set the denominator of their $\mathrm{d}y/\mathrm{d}x = 0$ generally produced perfect solutions.

Question 12

In parts **(a)** and **(b)**, incorrect answers were rare. Common incorrect responses in (a) were 125 and in (b) the usual incorrect method was seen when attempting to take lns at an incorrect point. Example: $50\,\mathrm{e}^{0.2t} = 800 \Rightarrow \ln 50 \times 0.2t = \ln 800$

In **(c)**, most candidates chose to apply quotient rule in an attempt to find $\mathrm{d}N/\mathrm{d}t$. Very common errors were seen where $\left(\mathrm{e}^{0.2t}\right)^2$ was incorrectly processed as $\mathrm{e}^{0.04t}$ or $\mathrm{e}^{0.2t^2}$. Candidates who chose to apply product rule were seen but were not as successful.

Part **(d)** proved to be the most challenging part of this question. A significant number of candidates did not achieve a 3TQ in $\mathrm{e}^{0.2t}$ and hence lost all marks. Candidates seemed to lack confidence in manipulating questions involving e with many giving up or else somehow proceeding to a linear equation in an exponential similar to part (b).

Question 13

Parts **(a)** and **(b)** of this question on the trapezium rule were very well answered. Errors seen were usually limited to an incorrect value for the strip width and an incorrect form for the trapezium rule. Candidates should be advised to show all of their working in a question like this, including the substitution of the ordinate values into the trapezium rule, rather than just doing everything in their calculator and writing down the final answer.

Part **(c)** involved integration by parts twice. Some candidates chose initially to integrate the x^2 term resulting in an x^3 term; the candidates made no further progress. Of those who integrated by parts "in the correct direction", it was difficult to follow their working as they attempted to squash everything into one line. They would have been better advised to do the second integration by parts separately and then combine everything together; this could have also helped those who made sign errors in the second integration. The integral of 4^x was not universally known with the factor of ln 4 often being seen in the numerator rather than the denominator. Another notational problem was in the writing of the powers of ln 4. Although, for example, $\ln^2 4$ was accepted for $(\ln 4)^2$, it was often more difficult to give credit an expression such as $\ln 4^2$, For part **(d),** the candidates were required to use their answer, which needed to be in a correct form, to find the area of region R. Centres should advise their students in such a question to show all stages in their working. Too many candidates merely wrote down 0.136 without any evidence of working, with some clearly using the integration function on their calculators to produce their answer.

Question 14

Part **(a)** was accessible to all the vast majority scoring full marks. The majority of candidates attempted to use $\mathrm{d}y/\mathrm{d}x = \mathrm{d}y/\mathrm{d}t$ divided by $\mathrm{d}x/\mathrm{d}t$ and overall it was correct. Occasionally candidates did not find values of x and y when $t = 2$ and were unable to progress. Almost everybody was able to find the gradient of the normal using the value of the derivative and hence went on to find the equation of the normal. A few candidates attempted to write y in terms of x and then differentiate using chain rule but solutions via this method were less successful.

Part **(b)** was found difficult by most candidates with many not attempting it at all. Most attempted to substitute for x and y into the equation of the normal and then stopped. A few attempted to work with a cartesian equation $(x-12.5)^2+(y-15)^2 = a^2$ but again failed to go much further. Complete methods were rare and evidence of very good candidates. Some methods were better than others at establishing both values for a, but a diagram would have certainly helped in understanding the problem for many.

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