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Examiners' Report
Principal Examiner Feedback

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

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IAL Mathematics Unit Core 34

Specification WMA02/01

Geneal Intoduction

Students seemed to have been well prepared for this examination. Some excellent scripts were seen and there were fewer students who scored very low marks. It proved to be an accessible paper with a mean mark of 81.6 out of 125. Timing did not seem to be an issue either, with most students able to complete the paper. Students should be encouraged to set their work out in a logical manner. Points that should be addressed by centres for future examinations are;

- a failure to recognise the need to use earlier parts of questions, especially when prompted to do so in a question. This was evident in questions 2 and 12
- a failure to show sufficient working in a question involving proof/show. This was evident in questions 3, 7, 8 and 9

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Reports on Individual Questions:

Question 1

The first question on the paper was, in general, answered very well and almost everyone attempted it. Students demonstrated their competency with implicit differentiation and many produced a faultless solution. Where marks were lost it was mainly due to the inability to differentiate 3^x with common attempts resulting in $x\ln(3)$ or 3^x. Pleasingly, the appearance of an extra $\frac{dy}{dx}$ at the beginning of the line of implicit differentiation was very rare. In general, good algebraic skills were displayed when rearranging to find an expression for the gradient. However a surprising number of students, having differentiated the x to 1, then 'lost' the one when substituting the values $x = 4$ and $y = 11$. A very small number of students found the equation of the tangent, without specifically stating $\frac{dy}{dx}$ indicating that the candidate had not read the question properly.

Question 2

In part a) most students scored marks in this question with many obtaining full marks. 25 or $125^{2/3}$ was taken out as a factor and the correct expansion found in unsimplified form. A common mistake was the use of $\frac{1}{25}x$ instead of $-\frac{1}{25}x$ which often led to an error in the sign of the x term.

In part b) many students worked out that $x = 1$ needed to be used in their expansion. Providing their expansion was correct most reached the correct final answer of 24.32889. Nevertheless two marks could be gained from an incorrect expansion as long as the students made their method clear. A small number of students used their calculator to evaluate $120^{2/3}$ giving 24.32881 but gained no marks as they clearly had not addressed the demand of the question.

Question 3

For many students this was another well rehearsed question and good source of marks.

The majority of students gained both marks for part (a), demonstrating their understanding of the relationship between natural logarithms and exponentials. The most common loss of mark in this part was the omission of the initial step of setting $f(x) = 0$.

In part (b), students were highly successful with most scoring full marks. The occasional student rounded incorrectly, losing just one accuracy mark. Many did not show the substitution of the first value into the expression, but a correct answer implied the method. There were only a very few students who obtained completely different answers; this was quite possibly due to a slip on their calculator, but as they had not shown their working they could not even score the method mark.

Part (c) was the least well answered part in this question. Students most commonly used the values shown in main mark scheme for the interval end points. The evaluations of $f(x)$ at these points were generally correct, but it was not uncommon for either a reason or a conclusion to be missing. Where evaluations were incorrect it was often because students did not notice that the numbers were in standard form on the calculator and so were quoted incorrectly. A small number of students also chose an un-suitable interval, selecting one which did not include the root or choosing x values to 3 decimal places, so their work was invalid.

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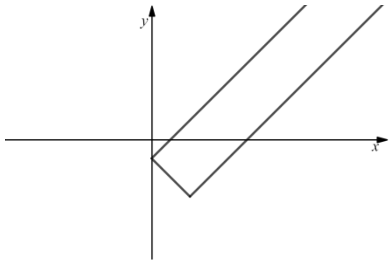
Question 4

Part (a) proved to be the more demanding part of this question. Many students failed to get the "W" shape and lost all three marks. A very common error was to produce a diagram of the form shown on the right.



Other ways in which marks were lost were

- Sketching $y = |f(x)|$ instead of $y = f|x|$ which gained a method mark for having a W shape.
- Failing to write down the coordinates of the y - intercept.

In part (b), students had rather more success and most managed to produce a V shape, usually with correct x and y intercepts. Common errors seen were translating the V 5 units to the right or introducing a y scale factor of ½ to give a minimum point of $\left(-3, -\frac{3}{2}\right)$

If students draw intermediate stage graphs, they need to make clear which diagram is their actual solution.

Question 5

In part a) most students recognised that the given expression needed to be split into two separate fractions and that the denominator needed to be factorised.

Poor factorisation of $16 - 9x^2$ e.g. $(3x + 4)(3x - 4)$ caused the most issues as it limited students to the only the method mark in this part of the question. A few students went down the route of using $\left(\frac{4}{3} - x\right)\left(\frac{4}{3} + x\right)$. Frequently this led to complications (for example forgetting that they had taken out a factor of 9) and as a result these students tended to score less well. The methods for finding the numerator constants were well known and both substitution and forming and solving simultaneous equations were seen. Many obtained full marks in (a).

In part b) only the stronger students obtained the final two marks, whilst almost all students scored the first M1 for integrating their two reciprocal terms to ln(…). The first A1 was often lost because students failed to divide by the coefficient of their x term. Most students attempted to combine their two ln functions but if they failed to include a constant of integration they were unable to score either of the final two marks. Very few were able to express the constant of integration as part of their final ln function, most giving their combined ln function + c as their answer. Those that managed to usually did so by stating that $c = \ln(k)$.

Question 6

Most students were able to gain some marks in this question and many fully correct responses were seen. A few students however, failed to realise they had been given y^2 and squared $3\tan\left(\frac{x}{2}\right)$ in an effort to find the volume. Having done this, no marks were possible. Students with the correct starting point usually gained both M marks with common errors being the loss of the A marks due to an integrated form of $3\ln\sec\left(\frac{x}{2}\right)$ instead of $6\ln\sec\left(\frac{x}{2}\right)$

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Question 7

A pleasing number of students achieved full marks on all parts of this question.

In part (a), almost all students attempting the question achieved the first 2 marks, and most the first 3, finding both parameters $\mu = -3$ and $\lambda = -4$ by solving simultaneous equations. However many did not go on to check these values in their remaining equation to show that the lines intersect. Of those who did check that the values worked in all 3 equations, a significant proportion then failed to state any type of conclusion. Students need to remember to put at least a tick mark or some form of conclusion after showing these values satisfy all equations, rather than just finishing with eg 8 = 8. Of those who did go on to find the position vector of the point of intersection, the majority achieved the correct answer although a few arithmetic errors were seen.

In part (b) most students attempted to use the correct formula and many went on to achieve the correct answer. Common errors seen for loss of marks were

- using the vectors $\begin{pmatrix} 13 \\ 15 \\ -8 \end{pmatrix}$ and $\begin{pmatrix} 7 \\ -6 \\ 14 \end{pmatrix}$ instead of the direction vectors.
- finding the obtuse angle instead of the acute angle.

Part (c) was attempted by most students. The most common reasons for failing to gain the mark were for not giving any form of conclusion, for only testing two of the co-ordinates of point *A* or for stating $\lambda = 6$ rather than -6.

Part (d) was also a good source of marks for many students. Most used the vector approach, finding vector ***AB*** first, although some also found ***OC*** directly from ***OA*** and ***OB***. Numerical slips on one or more of the components however were quite common. A small minority used vector lengths and Pythagoras to find the value of λ at *C*, and although they usually had a correct method, most made slips meaning $\lambda = -2$ was only found occasionally. Poor notation in the final answer was penalised, so that the answer in coordinate form $(7, 9, 0)$ lost the final mark.

Question 8

The majority of students made a start to this question and differentiated correctly to get $16\sec^2(2x)$. The most efficient way of reaching the answer was to take the reciprocal, use the identity $1 + \tan^2 2x = \sec^2 2x$ before replacing $\tan 2x$ by $\frac{y}{8}$

Using the double angle formula for tan2*x* was usually futile but there were many good solutions seen by replacing $\sec^2 2x$ by $\frac{1}{\cos^2 2x}$ and using a triangle approach with $\tan 2x = \frac{y}{8}$.

Given the demand of this question, it was pleasing to see a high proportion of students who were able to reach the required form successfully, although, as always, there is the need for students to be alerted by the word ‘show’ in a question and to take care to show all of their steps in order to gain full credit.

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Question 9

Part (a), in general, was well answered well. Most students were able to identify and correctly manipulate trigonometric identities in order to complete their proofs. When errors did occur, it was often through incorrect recollection of the identity $1+\cot^2 x = \text{cosec}^2 x$. There continues to be students who do not fully respond to the word 'show' in a question and are not including all necessary steps in their working. This can be especially true of more able students who can clearly see the way to the solution and are over-economical with their explanations.

In part (b), most students began with the correct double angle formula $\cos 2x = 2\cos^2 x - 1$. When errors did occur, they were mainly due to sign errors leading to an incorrect three term quadratic equation. Whilst many students calculated two correct angles, a significant proportion then failed to find all four correct angles for the final accuracy mark. A common error to obtain the second value of $\arccos\left(-\frac{4}{5}\right)$ was to calculate it as (180°-143.1°= 36.9°) instead of 36.9° + 180°.

Question 10

Working with functions continues to be a topic that cause problems for some students, particularly the ideas of domain and range.

In part (a) most students gained both marks for an accurate sketch of e^{-2x}. However, there were a number who forfeited the accuracy mark due to either poor sketching with respect to the horizontal asymptote (either not levelling out to the *x*-axis, not being close enough or allowing the tail to rise again), or giving an incorrect *y* intercept. Among other errors frequently seen was to sketch the graph of e^{2x} instead of e^{-2x}.

Part (b), finding the range of g(*x*), caused problems for many. Sketches of the function were rarely seen which could explain why so many students did not realise which *y* values were relevant for the function. Many were successful in working out that the value of 1 was pertinent to the solution, but the correct range was not commonly achieved with solutions such as $0 < g(x) < 1$, or $g(x) \neq 1$ and so on being given. Notation was usually good in this part, though, with g(*x*) often being used.

For part (c), finding the inverse function of g was done well overall, with the first two marks gained by most students attempting the question, and often the first three. Where the third marks was dropped, it was commonly due to failing to return to the correct notation, leaving the answer as $y = ..., f^{-1}(x) = ...$ rather than $g^{-1}(x) = ...$ Slips in accuracy did occur when rearranging, but this was less common. The final mark also proved troublesome, either due to incorrect notation (often using g^{-1} instead of *x*) or omission of a domain entirely. Some students did show an appreciation that the domain of the inverse is the range of the initial function, with answers following through from part (b) A small number still continue to interpret $g^{-1}(x)$ as $g'(x)$ and differentiated

Part (d) was done very well, easily the most successfully answered part of this question, with most students scoring full marks for obtaining the required value of *x*. There was only a very small minority who did not get started in this part, though some case of composing the wrong way were seen. Most students were able to form the equation correctly and most of these went on to correctly undo the exponential. The final two marks were the most variably answered; some students resorted to inexact values for ln3, while others struggled to manipulate the equation correctly in order to make *x* the subject. However, the majority did achieve a correct answer, although there were many (correct) variations seen.

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Question 11

Parts (b) and (d) proved to be demanding in this question.

In part (a), a good proportion of students achieved $(3,0)$ and $(-3,0)$. The majority of students who did lose marks failed to give the coordinates, just giving $x = \pm 3$. .

Part (b) did not have many fully correct solutions. The most common answers were $t = \pi/2$ without considering a second value for t, or writing $t = 0$ and $t = \pi/2$. Some students found lots of values for t but did not select the correct ones. Degrees were occasionally used instead of radians.

Part (c) was very well done and many students achieved full marks. Even those with poor differentiation skills were usually still able to access both method marks. Amongst slips made were having $dy/dt = 9 \cos 2t$, $dy/dt = 9/2 \cos 2t$, $dy/dt = 18 \cos t$, $dy/dx = -3\sin t/18\cos 2t$.

Part (d) was an effective discriminator with more able students often scoring full marks. However, it was also very common for students to only score the first mark. A variety of methods were used. The first mark was easily achieved by writing $y = 9\times 2 \sin t \cos t$, though when it came to squaring y, there were some who did not square the 2. Substituting $x = 3\cos t$ and using an identity to get the equation in terms of x and y was often well done. However, slips were often made in the subsequent work resulting in the loss of either one or both of the accuracy marks.

Question 12

Part (a) was familiar territory and most students scored full marks. Marks were lost for writing R as a decimal, getting -1.11 for the angle or working out inv tan(0.5). Rounding errors were sometimes seen resulting in an angle of 1.12. .

Students were less successful in part (b) with quite a number misinterpreting the question, and working out the value of t at which the maximum and minimum occurred. Some got as far as writing the maximum $12 + 4\sqrt{5}$, but used $\sin x = 0$ for the minimum value getting an answer of 12.

Part (c) was often well attempted with a substantial number of students getting full marks. Most students interpreted the model, writing it in terms of part a, but there were some who tried to use $2\sin x - 4\cos x$. Moving on to make $\sin(x - \alpha)$ the subject was achieved by most, but some then used an incorrect order of operations in proceeding to make t the subject. Many students achieved one correct answer of $t = 99$ but failed to consider a second angle when calculating inverse sine.

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Question 13

In part a) the majority of students successfully used the trapezium rule to calculate an estimate for the area required. The trapezium rule structure was generally correct with few incidences of missing brackets. Occasionally students gave their answer to greater accuracy than the 3s.f. stated in the question. The most common error, was to use $h = \frac{5e - e}{5}$.

In part b) a significant number of students attempted the substitution $u = \ln(2x)$ but found $\frac{du}{dx}$ incorrectly as $\frac{1}{2x}$. Some students attempted to use "parts" even though the question directed them to use substitution and thus gained a maximum of 1 mark. Most students who had used the given substitution arrived at an integral of ku^2. For those achieving $\frac{1}{4}u^2$ or ku^2 many then failed to substitute $u = \ln(2x)$ back into their integral and hence lost the final A1 in this part. A few who did replace u gave incorrect answers in terms of x, e.g. $\frac{\ln(2x)^2}{4}$ instead of $\frac{[\ln(2x)]^2}{4}$.

The notation $\frac{1}{4}\ln^2(2x)$ was accepted.

In part c) many were able gain the two marks even if they had left their integral in terms of u by changing their limits correctly. Many gained both marks in this part and recovery from incorrect notation e.g. $\frac{1}{4}\ln^2(2x)$ was allowed.

A number of students did not attempt part d) especially when they had struggled in earlier parts of the question. Most who did attempt it tried to differentiate y using the product rule or quotient rule. Many students differentiated $\ln(2x)$ incorrectly again and lost the first accuracy mark here. A number also lost the marks because they wrote or interpreted $\frac{1}{2x}$ as $2x^{-1}$ before differentiating using the product rule. The last three marks of part (d) were demanding but there were many accurate solutions. Loss of marks were common for not realising that $\ln 2 \times \frac{e^2}{2} = 2$ and struggling to simplify their tangent equation into the required form.

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Question 14

Part (a) was accessible to all students with very few incorrect answers seen. Virtually all candidate where able to differentiate *V* correctly.

Part (b) was also generally answered well, with only a small number of students making errors in the method of the chain rule. However, some did not simplify correctly, usually failing to cancel out the π. A small number miscopied the '9000' as '900'.

It was in part (c) that problems surfaced for students with a wide variety of responses. There was a significant proportion who completely missed the idea of separating the variables, instead attempting to integrate the terms in place on the right hand side, while others substituted $r = 3$ into the equation to first obtain an equation in t only before integrating. Those who did managed to separate the variables were generally able to proceed to integrate to an acceptable form, though dealing with the index in the $(t + 81)^{-5/4}$ led to various errors. More often it was the constant multiple that was incorrect, multiplying by $-\frac{1}{4}$ rather dividing but the incorrect form $(t + 81)^{-9/4}$ was also common. Of those that did achieve a correct integral with constant only a very few actually went on to make r the subject.

The final two parts, (d) and (e), often resulted in B0 M1A0, when attempted following an incorrect answer to (c). The final M mark for substituting the found value of r into $\frac{dr}{dt}$ was often gained even following poor attempts at (c), as long as a value of r was reached.

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