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Examiners' Report

Summer 2016

Pearson Edexcel IAL in Core Mathematics 34 (WMA02/01)

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Mathematics Unit Core Mathematics 34

Specification WMA02/01

General Introduction

Some students did not take note of the instructions in the questions, for example to leave answers as their ‘exact value’, or to the required level of accuracy required in a question.
Some students clearly enter numbers into a calculator without writing down the calculation, meaning that if errors are made on the calculator both method and accuracy marks could be lost (for instance showing the substitution of values clearly in a definite integral).
The above said, there were many encouraging examples of neat, well-structured answers to questions, which were a pleasure to read and assess.

Report on Individual Questions

Question 1

Q01(a) was an accessible task with most students able to find R and $\tan\alpha$ through a well-practised routine of $R = \sqrt{(3^2 + 5^2)}$ and use of $\tan\alpha = \frac{5}{3}$ ($\frac{3}{5}$ was quite rare) but some failed to read that an exact answer for R was required and some lost accuracy marks by rounding α to only 1 decimal place. Where students expanded $R\cos(\theta - \alpha)$ it helped them to the correct solution. Students who used $\sin\alpha$ or $\cos\alpha$ to find R did not achieve an exact answer. The use of radians was very rare.

In Q01(b) most understood the link between Q01(a) and Q01(b) writing $\cos(\theta - 59.04) = \frac{2}{\sqrt{34}}$ and found $\theta - 59.04 = 69.94$. Leading to $\theta = 59.04 + 69.94 = 128.98$ rounding to 129.0. However, a significant minority were unable to round their answer correctly. $59.04 + 69.9 = 128.9$ was a very common answer. Most went on to find a correct second solution, even if they had lost the A mark for their first solution.

Q01(c) proved more challenging with more frequent blank answers and some trying to minimise $\cos(\theta - 59.04)$ rather than θ. However, a few recognised the link between Q01(a), Q01(b), and Q01(c) readily giving $69.9 - 59.04 = 10.9$. The few students who started again were usually successful.

Question 2

Students found this quite an accessible question. Most students attempted to apply the product rule on the $4x\sin x$ term usually successfully. There were some sign errors in the $\cos x$ term and a minority did not recognise the product, merely writing $4\cos x$, and less common still was differentiating to $4x\cos x$. The chain rule was usually correct but caused more errors and the $2\pi y\frac{dy}{dx}$ term frequently lost one of its components. If the y was lost this also meant the 3rd M mark couldn't be scored. Some rearranged to get an explicit function, often incorrectly, before attempting to differentiate. Those who obtained a $\frac{dy}{dx}$ in their expression were usually able to evaluate it at the point $\left(\frac{\pi}{2}, 1\right)$. Mostly they then took the negative reciprocal value and used this in the equation $y - y_1 = m(x - x_1)$ to give a correct answer. The usual errors were just using $\frac{dy}{dx}$ or +1/... for the normal rather than -1/... Decimal answers to 3sf or more were given full credit and correct answers were credited when first seen with subsequent work being ignored.

Question 3

This question was well done by the majority of students. Some lost marks because of minor algebraic mistakes or failure to select the required value of a.
In Q03(a) most applied the binomial expansion well with only a small minority badly bracketing their terms ie failing to bracket “ax” leading to incorrect powers of “a.
In Q03(b) most multiplied their expansion by $(2+3x)$ and successfully found the terms in x^2 and then formed the correct quadratic equation. Many omitted the brackets around $(2+3x)$ but multiplied out correctly and so were not penalised as the brackets were implied by correct work. Some selected the required products to obtain the coefficient of x^2 without writing down the full expansion of the product, but this was acceptable. A common error was to ignore the multiplication by (2 + 3x) and equate the coefficient of x^2 from the expansion in Q03(a) to 3. As a result they did not have two terms for the coefficients of x^2 or x^3 and so could not score marks in Q03(b) or Q03(c). A number did not use a correct method to solve the quadratic; typically they would fail to rearrange their equation so that the RHS was zero.
Most of those solving the quadratic equation correctly then selected the correct value of $a=-\frac{1}{4}$ but a number incorrectly and strangely selected “1” even after writing $a<0$ next to it. A number did not make a selection and also lost the final mark here.
Some students thought it necessary to use the binomial expansion again to expand $(2+3x)$, a very few applying a power of -3 and thus losing the marks in this part.
In Q03(c) most students who gained marks in Q03(b) understood what was required to find the coefficient of x^3 and substituted their value of a, giving the coefficient as their answer. Occasionally they used both values of a and gave two answers, and a few made a sign error with the $-18a^3$ when substituting in $-\frac{1}{4}$.

Question 4

On the whole this question was well answered. Q04(a) was more challenging than part Q04(b) where, if an incorrect value for B was found in Q04(a), it was still possible to get 4/5 marks in Q04(b).
In Q04(a) students who attempted an algebraic long division approach to this question were usually successful, setting their expression as $\frac{\text{quotient} + \text{remainder}}{(x+3)(x+4)}$, then cancelling $\left(x+4\right)$ to obtain the correct values for A and B following the main scheme.
Many chose to adopt a partial fractions method to simplify the remainder, still obtaining the correct answer. Some obtained a correct quotient and remainder but did not do any further work, so achieved 2 out of the 4 marks.
Students who tried a comparing coefficients or "partial fractions" approach were usually unsuccessful as a result of incorrectly multiplying the RHS by the denominator of the LHS. Some simply equated the quartic to partial fractions $\frac{A}{(x+4)}+\frac{B}{(x-3)}$, ignoring the form of the RHS given. Often, $B(x+4)$ was obtained on RHS allowing the first method mark. In many cases, a completely incorrect equation was obtained but two equations for A and B were then obtained and solved, still gaining one mark out of four.

Those who tried to use the division by linear factors rarely achieved all the marks, often forgetting to do both divisions, or losing their way in the process which had to be completed to earn the first method mark, or otherwise making errors in the considerable amount of algebra required.

In Q04(b) differentiation of x^2+5 was generally done correctly, but differentiating $\frac{3}{(x-3)}$ was not. The most common erro, was writing $\frac{dy}{dx}=2x+3\ln(x-3)$. Other errors included $\frac{+3}{(x-3)^2}$, $\frac{-3}{(x-3)}$ and some students attempted to use the quotient rule on $\frac{3}{(x-3)}$ or indeed on the original function, with the formula rarely quoted. There were examples of the quotient rule being used correctly, but an error when using it on $\frac{3}{(x-3)}$ was to have a "1" as the derivative of "3".

Generally speaking, if the differentiation was done correctly then the question was correctly finished off and the correct equation eventually found. In most cases, even if the differentiation was wrong the 2 subsequent M marks were obtained for a correct method of finding the tangent equation. Very occasionally the equation of the normal was attempted.

Question 5

Many were able to integrate by parts and had no difficulty with choosing u and $\frac{dv}{dx}$, although it was rare to see a correct final solution. A big problem was integrating the parts the right way round and failure to do this led to no marks because of the dependency.

Few students quoted the formula and for some this led to confusion. The most common errors were multiplying by ln 2 rather than dividing or just assuming $\frac{d}{dx}(2x) = 2^x$ but most who started correctly were able to obtain the first four marks by reaching $\frac{x2^x}{\ln 2} - \frac{2^x}{(\ln 2)^2}$. There were some examples of 2^x being wrongly integrated as $\frac{2^{x+1}}{(x+1)}$.

Some used $e^{x\ln 2}$ instead of 2^x and generally they were able to complete the integration without difficulty – although the error of multiplying by ln 2 rather than dividing still occurred with this approach. Sometimes 2^x was integrated correctly but then $\frac{2^x}{\ln 2}$ integrated incorrectly.

The majority were able to successfully handle limits and subtracted the right way round. A few failed to recognise that substituting the limit of 0 did not result in a zero term. The requirement for a single simplified fraction led to some losing an accuracy mark with some unable to combine the terms to obtain a common denominator.

Question 6

This question was done well by the majority of students with many fully correct answers

In Q06(i) there were relatively few errors although some students did not show the intercepts or had the “V” shape passing through the origin.

In Q06(ii) common errors included either a failure to translate their shape from Q06(i) or translating horizontally rather than vertically. There was also a failure to mark the horizontal axis with intercept values on many occasions, (a-b) marked on negative y axis. However, wrong graphs (eg W shaped) often had (0, a-b) marked in the correct place.

Q06(b) was often completed completely independently of Q06(a). Very few students used a sketch to help their understanding of the problem. Most were able to find the 2 correct necessary equations, but errors in solving them were common. Errors were made transcribing the –b and also dealing with the fractional co-efficient when solving for x. Many left their final answer as two separate inequalities rather than a combined inequality. Some students attempted to square both sides but were rarely successful in obtaining the correct inequality.

Question 7

In Q07(a) the majority were able to apply the trapezium rule correctly, giving their answer to the required degree of accuracy. Having to form their own table of values led some to make errors. Some left the y values in the table as surds while some used decimals, mostly to 4dp. A common error was miscalculating the value of “h” even when their table implied the strip width had to be 1. Use of decimals in the table sometimes meant that the final answer was not given to the required accuracy. Some used two strips only (presumably interpreting the instruction to use three strips as using three y values), although the method mark was available still for a correct application of the trapezium rule. A very few used x values starting at 0 or 1 instead 2 losing three marks at least.

In Q07(b) many students gained full marks. Some gained the first M mark for an integral of the correct form, but did not obtain the correct value for k often giving k = 2 or k = 4, usually as a result of forgetting to divide by the “2” of the 2x. Some obtained a correct un-simplified expression but made mistakes is simplifying the fractions involved, usually having a “4” instead of a “1”, losing the second accuracy mark. Those who chose to integrate using substitution were usually successful, but subject to similar errors in obtaining and simplifying the constants arising; some forgot to change the limits of the integration losing the second M and A marks. Having obtained the correct integral many ignored the word “exact” in the question giving a decimal answer, and some did not show substitution of the limits 5 and 2 and gave only a decimal answer thereby losing 2 marks.

In Q07(c) three calculations of “error” were seen, namely magnitude of the error, the percentage error, and relative error, and all were accepted if found correctly. The question asked for the magnitude of the error of the estimate; students should be advised that they should be careful to answer the questions as set.

Many students had quite different answers in Q07(a) and Q07(b) but clearly did not check and correct errors which were usually from an incorrect factor of 2 or 4 in Q07(b). The comparison of answers in questions of this type should be encouraged.

Question 8

Q08(a) had some very clear, well-presented proofs. Many scored 3 or 4 out of 4 in this part. Students knew, and used the identities for $\sin 2x$ and $\tan x$ and obtained a common denominator before factorising their numerator with $\sin x$ outside the brackets and, recognising the identity for $\cos 2x$, reached the required $\cos 2x \tan x$. However, some reached as far as a correct fraction in $\sin x$ and $\cos x$ but did not proceed any further. The first M mark for using the correct identity for $\sin 2x$ was gained by almost all students who attempted this question.

Alternative methods used were starting from the RHS to obtain the LHS or working on both sides until they reached LHS = RHS, although in the latter method a conclusion was required for the final mark and this was often not seen. Some students took a long winded approach, changing the $\cos 2x$ identity into its various forms before finally reaching the correct expression.

Occasionally a student multiplied the LHS by $\cos x$ without putting in a denominator which was costly, losing three marks usually despite correct work for the numerator, and sometimes the appearance of the $\cos x$ denominator further on.

In Q08(b)(i) the majority of students used the identity from Q08(a) and reached $\tan\theta\cos 2\theta = \sqrt{3}\cos 2\theta$ and removed the common factor of $\cos 2\theta$ to get $\tan\theta = \sqrt{3}$ and $\theta = \frac{pi}{3}$. However, only a few set $\cos 2\theta = 0$ and got $\theta = \frac{pi}{4}$ as a second solution.

In Q08(b)(ii) most managed to obtain the required $\tan(\theta+1) = -2$. A few missed seeing relationship with the proof in Q08(a) and expanded $\tan(\theta+1)$ using the relevant addition formulae. A number approached this by letting $x = (\theta+1)$ reaching $\tan x = -2$ and subsequently correctly finding θ. Many got to $\theta - 2.1...$ but failed to obtain the positive value so losing the A mark. The final answer of $\theta = 1.03$ was sometimes not obtained to the required accuracy because students had truncated or rounded values in the earlier working. Those who reached $\tan(\theta+1) = -2$ invariably used the correct order of operations to reach $\theta = -2.107$ but then many failed to add π to get the correct solution in the range so only scored 2 marks. Some used $\tan\theta = 2$ and reached as far as $\theta = 0.107$ which still gained them 2 marks.

Many did not appreciate the link with Q08(a) and tried to solve by changing tan into sin/cos. Some used the tan(A + B) identity and managed to reach a correct solution. Also seen occasionally was the incorrect expansion of $\tan(\theta+1) = \tan\theta + \tan 1$, or even $\tan\theta + 1$

Question 9

Q09(a) was usually completed correctly.

Q09(b) was found to be less accessible. Many students found it challenging to find the limit of the given function. This part was missed out by many students, or infinity or 9000 was given as the answer.

Q09(c) was completed well by many students. Reaching the e^{4k} was usually achieved but a significant proportion of students had problems with their log work eg $\ln 15e^{4k} = 4k \ln 15e$. A number of students went straight to a decimal answer from $e^{4k} = ...$ while some gave the decimal answer with no calculations or method shown at all.

In Q09(d) it was rare to see full marks. For those who attempted this part, the usual method was to use the quotient rule, while a significant minority treated it as a product. Some very good attempts of these were seen. Those that substituted for k before differentiation achieved an untidy looking rational function. They would have found the expression easier to manage had they left it in terms of k. Some then wrote t = 10 but did not demonstrate any usage of it and if they obtained a wrong answer they forfeited two marks. A few substituted for t before differentiating, resulting in the loss of all marks. However, it was pleasing to see a few elegant solutions, dividing denominator and numerator to achieve a simpler function followed by chain rule differentiation.

Question 10

This was one of the more challenging questions on the paper. Many missed out one or more parts completely though the majority scored marks in Q10(d) even if they had not attempted earlier parts. Q10(c) and Q10(d) were usually well answered with few incorrect solutions seen – students were clearly well prepared for this part of the syllabus.

In Q10(a) most students gained some credit; the graph of $y = \tan x$ was a common response as was $y = \cot x$. Other common errors were to rotate the correct graph through $90°$, reflect it in the x or y axis or fail to show the gradient tend to 0 as x tends to $\pm$ infinity. In general it was clear that the graph of $y = \arctan x$ was not well known.

In Q10(b) common errors were to confuse $\arctan x$ with $\cot x$ or to think $\tan{-1}x = \frac{1}{\tan x}$ and also to forget about the brackets and consider $\arctan(x+1)$ to be $(\arctan x)+1$. Those who substituted correctly to get to $\arctan(x+1) =$ often went on to get the correct exact answer $\sqrt{3}-1$, although a number gave a decimal answer believing it to be “exact”. A few used degrees instead of radians. A small number subtracted 1 before finding $\tan\left(\frac{\pi}{3}\right)$.

In Q10(c) most students knew what to do substituted $x = 5$ and $x = 6$ into the function achieving two answers usually to 3dp or better. However, a few used $\arctan(x - 4 + \frac{1}{2}x)$ or substituted into $\left(x - 4 + \frac{1}{2}x\right)$, omitting the arctan function altogether. Others rearranged the equation and attempted to solve it algebraically. A few mentioned “sign change...” but omitted to give a conclusion, losing the A mark.

For Q10(d) most just wrote the two required roots to the correct accuracy. A few gave an extra iteration and a few worked in degrees.

Question 11

Most students began this question correctly, writing down three simultaneous equations and using two of them to find the values of λ and μ. They then checked these values into the third equation to show that $b = -3$. Some then forgot to find the coordinates of the point *X*. A majority of students gave the position vector of *X* but this was accepted as alternative notation.

In Q11(b) the question asked students to show that the angle *AXB* was $\arccos\left(\frac{-1}{10}\right)$. Some began by finding the vectors AX and BX and then used a scalar product. A common mistake was using OA and OB instead of XA and XB. Others used the direction vectors of the two given lines and used a scalar product. A minority used the cosine rule. Any of these methods were acceptable and could lead to a correct answer earning the full four marks. Some lost the final mark because they left their answer as $\cos AXB = -\frac{1}{10}$. Others lost both accuracy marks because they found the scalar product of AX and XB and obtained $\cos AXB = +\frac{1}{10}$. As the answer was given the working for the scalar product needed to be shown and not just stated for the award of full marks.

Q11(c) was discriminating. Students needed to find an exact answer for sin *AXB* and to use this to obtain a correct answer for the area of the triangle. Merely giving decimals, which the majority of students did, lost two of the three marks. Some forgot the half in the triangle formula, and some used vectors OA and OB, or the direction vectors of the lines to find the required lengths instead of using AX and BX.

Question 12

The techniques assessed in this question were well known by the majority of students, who were able to confidently change dx to dt and use the formula for the volume of revolution successfully. However there were signs that some students may have run out of time or alternatively struggled to find a volume of revolution when presented with equations in parametric form.In Q12(a) most knew that volume was found using the integral of $\pi y^2 dx$, and there were many who knew how to find the volume from parametric equations. They were able to reach a correct expression for V in terms of t, gaining the first 2 marks. It was clear that most knew the formula for $\sin 2t$, but sometimes did not progress from $(2\sin 2t)^2$ to $16\sin 2t\cos 2t$ correctly, resulting in k = 24 or k = 12 rather than the correct k = 48. Some wrote the correct $(2\times 2\sin t\cos t)$ but forgot to square both 2's; others simply replaced $2\sin 2t$ with $2\sin t\cos t$. Many students worked separately on the various parts required in the integral and then assembled the correct expression. Students adopting this approach tended to be more successful. Some lost the factor of "3" from their "$3\cos t$"when calculating k. Most correctly found the value of the limit a. There were a few, who, on seeing parametric equations differentiated both y and x with respect to t and found dy/dx. Others expressed the volume incorrectly as the integral of y dx. Presentation of the final expression usually included the "dt", although some lost the final A mark for its omission.For Q12(b) there were good attempts at integration by the given substitution $u = \sin t$. Most found $\frac{du}{dt} = \cos t$ (with a sign error here quite rare) and went on the find an integral just in terms of u using an acceptable identity for cost in terms of $\sin t$ and hence u. There were errors in multiplying out the brackets to get a polynomial and most multiplied out and integrated sufficiently well to gain the M mark.

For those who made progress, many could do the integration properly, although coming out with an incorrect final answer because of an error in the multiplicative constant in (a). Once again, students are well advised to show the substitution of their limits and subsequent subtraction rather than just show the result of their working

There were a few who tried unsuccessfully to integrate the product using "parts", and some forgot to change the upper limit to 0.5 from $\frac{pi}{6}$, and so lost the last 2 marks.

There were some who did not progress in Q12(b) beyond stating $\frac{du}{dt} = \cos t$. This may indicate students had run out of time. Some tried substituting but never reached an expression just in terms of u, and a few even attempted to integrate expressions which were a mixture of $\sin t, \cos t$ and u.

Question 13

This question was found to be challenging, though Q13(b) was a source of three accessible marks.

Students were well prepared to answer Q13(a) on the applications of the chain rule. Most found $\frac{dv}{dh}$ properly but those who expanded the brackets first found it easier than those who tried to use the product rule. Mostly the methods were correct but many had difficulty producing a clear concise proof of the result and the most common error was to lose the minus sign in the final answer. Some students did not show enough steps enough to gain full marks. Factorisation was often not clear and use of brackets was weak. Some resorted to cancellation and made errors. It was quite common for students to try to correct their response in an effort to get the given answer.

Q13(b) saw 30 times 20 become 60 rather than 600 in some instances and the most common error was for A to become 2 instead of 20. The substitution method was more common and effective than comparing coefficients. Many students however were able to score all 3 marks.

Students found Q13(c) particularly difficult and many did not even attempt it. Separation of the variables was not clearly stated by many and the negative sign again disappeared in many solutions. The integration usually gave two log terms, but sign errors were common. Some had $\ln(h-30)$ instead of $\ln(30-h)$. This caused problems when values were substituted for h, resulting in logs of negative quantities. Limits were used in a minority of solutions, while most others used a constant, which was found from the initial condition. The final answer of $t = 11.63$ from correct working was usually indicative of a good student.

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