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Examiners' Report

Summer 2015

Pearson Edexcel International Advanced Level in Core Mathematics C34 (WMA02/01)

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Mathematics Unit Core Mathematics 1

Specification WMA02/01

General Introduction

As last year, most students answered the paper well and demonstrated a good understanding of the specification. However there were a sizeable minority of very weak students who did not seem to have been prepared for this specification.

The first six questions and question 9 proved to be very accessible for most students, with mean scores above half marks, and the modal mark being full marks (apart from question 3, where it was 8/10).

The other questions on the paper were more challenging and provided greater discrimination, but almost all students could make a start on these questions provided that they had allowed sufficient time to attempt them.
Performance in answering questions 7 and 8 appeared to highlight some weaknesses in skills or knowledge of trigonometry. Errors were common with inequalities in question 3, simplifying rational expressions in question 5 and formulae for area and volume in question 10. Students at some centres showed lack of confidence tackling vector questions. Algebraic errors were common with erroneous arguments such as $ax^2 + bx + c = 0$, $ax^2 + bx = -c$, $x(ax+b) = -c$ appearing in several questions.

Report on Individual Questions

Question 1

The mean mark was 6.28 and 43% of students scored the full 9 marks. This year 12% gained no marks (16% last year) and this is surprising on this accessible topic. The question was very familiar in style and proved a good opener to the paper.

In part (a) the first two terms were usually differentiated correctly but some students were less familiar with differentiating $2xy$. Some had only one term when differentiating this. Another common error was to omit " = 0" at the end of the expression.
Of those achieving the three marks for a fully correct derivative, most went on to rearrange to make $\frac{dy}{dx}$ the subject before substituting $\frac{dy}{dx} = 2$. The alternative, simpler, approach of substituting at the outset was much less commonly seen. The choice of rearranging first, sometimes led to the loss of the final two marks due to algebraic errors. However many fully correct solutions were seen to part (a), where the given answer enabled students to go back and find any errors.

Fully correct solutions to part (b) were seen, but less frequently than for the part (a). Of those realising that a substitution of $y = 6x$ was required, virtually all achieved at least two marks. Though some missed the x from the $2xy$ term giving $12x$ rather than $12x^2$.
A good number of students reached $x^2 = \frac{1}{4}$ but then failed to get $x = \pm\frac{1}{2}$.
Some students went from $x^2 = \frac{1}{4}$ to $x = \frac{1}{4}$, or just to $x = \frac{1}{2}$.

Giving the result as $x = \pm\frac{1}{2}$, $y = \pm 3$ did not secure the final A mark, as the coordinates needed to be paired. A fairly common error was to substitute the x values into the original equation and reach a quadratic with 2 solutions, which gave them 4 pairs of coordinates. This was penalised by A0 as the final mark.

Some students misunderstood what was required in part (b) and proceeded to a co-ordinate geometry approach, finding gradients and equations of straight lines.

Question 2

This was well answered by the majority of students and 36.5% gained the full 9 marks with a further 21% losing just one or two marks. The mean mark was 6.19. Again the surprising statistic is the 10% scoring no marks.

In part (a) those students who correctly set out $A(2 + x)^2 + B(1 - 2x)(2 + x) + C(1 - 2x)$ and substituted $x = ½$ and $x = -2$ usually went on to find A and C correctly and to show the given answer that $B = 0$. Another method used successfully was comparing coefficients. Some students made hard work for themselves by multiplying out the brackets first. Errors were seen when multiplying out brackets, notably with signs. Some used $(1 – 2x)\ (2 + x)\ (2 + x)^2$ as their denominator thereby making their identity incorrect. Quite a few students stopped after finding A and C and lost the final mark for showing that $B = 0$. Those who made errors and did not get $B = 0$ often seemed to accept this, instead of going back to check their work, even going on to use it in their expansion in part (b).

In part (b) the majority of students wrote $4(1 - 2x)^{-1} + 8(2+x)^{-2}$, expanded correctly, multiplied out and got the correct answer. Some made errors in the final step collecting terms eg rather alarmingly, $4 + 2 = 8$ was seen a number of times, as was $+8x + -2x = 10x$.

Other errors seen were sign errors, fraction errors and errors multiplying out brackets. A few multiplied their expansions instead of adding them. A few failed to take out the 2^{-2} from $(2 + x)^{-2}$. Some took 2^2 out.

A less popular method was to write the expression as $4(x^2+ 6).(1 - 2x)^{-1}.(2 + x)^{-2}$. Some fully correct responses were seen but many made errors when multiplying their expansions. Some students did not write their expressions with negative powers losing all the marks.

Question 3

Students found this quite an accessible question and the modal mark was 8/10. This was usually earned by correct answers to parts (a) and (c) and no attempt at part (b). About 40% of students scored 8 or more marks out of ten.

In part (a) most students attempted to apply the product rule, some deciding to multiply out the bracket first. Those students using the product rule usually did so accurately and achieved a fully correct expression for $f'(x)$. Very few quoted the formula before use. Although nearly all students stated the requirement for $f'(x) = 0$, solving this equation proved more problematic than the differentiation – the most common error involved trying to use ln to find solutions. A significant proportion of students did not give their *y* - coordinate in exact form.

Part (b) was the most discriminating part of the question. Of those students who found a *y*-coordinate in part (a), less than half realised that this should be used as the lower limit. It was rare to see 0 used as a limit, in fact 5 (or -5) was more common, if an upper limit was seen at all. Errors with the direction or type of inequality sign were also surprisingly common and a variety of letters were in their answer. Other common errors were to attempt to consider b2 – 4ac > 0 even though there was no quadratic to consider.

Part (c) was attempted by almost all students, irrespective of whether they had made much progress earlier in the question. It was clear that most students knew the method for producing the correct graph and the majority did succeed in sketching a graph with the correct shape. Errors with the shape were usually a minimum point on the *x*-axis rather than a cusp, or the asymptote being unclear. A small minority reflected in the *y*-axis. Students still need to improve their labelling of sketches as it was common for only one or neither point to be labelled. Some gave the *y*- intercept as “-5”, having calculated from the original curve.

Question 4

This was quite a simple question, with only the use of vector notation and the scalar dot product being C3/C4 content, but the question was answered quite poorly, in part because students did not appreciate the requirements of "exact" work, but in part because the vector context seemed to cause confusion. About 21% of the students gained the full 7 marks but 14% gained no marks.

A good proportion of students attempted part (a) using the dot product correctly, and were mostly successful in their attempts scoring 2 marks. Some students scored M1A0 from writing cos AOB = 20/(5×6), and then writing the angle in degrees, without giving a simplified answer for the cosine. The angle was frequently seen even after the correct answer of cos $\Theta = 2/3$. Some invented a right angle in the triangle and used Pythagoras to find AB; others seemed to use a length of 1 for AB most likely from having first done part (b) incorrectly, using the cosine rule with three known sides.

Part (b) was usually attempted but in far too many cases unsuccessfully, students not realising that they had to use the cosine rule, something learnt at GCSE and reinforced at AS Level. Those using the cosine rule invariably went on to be successful, although in many cases the computed angle from part (a) was used rather than the exact value of the cosine. However the unrounded value given on their calculators was evidently used, as they were still able to find the exact length as required, and there was no penalty here for non-exact working.

The most common error was to simply subtract the moduli of the two given vectors for a value of 1, the student clearly confused by what the question required.

In part (c) most knew and quoted the "sine" formula for area of a triangle. Students who went on to score all 3 marks usually found sin C from sketching a triangle and using Pythagoras; less often the identity $\sin^2\Theta + \cos^2\Theta = 1$ was used. Finding the perpendicular height and using "half base times height" was encountered, but not in large numbers of cases.

There were many cases of M0M1A0 being awarded because the sine of the calculated angle was quoted and used, and students obviously felt that they could then show that their decimal answer was equivalent to the $5\sqrt{5}$ and still earn the marks. Clearly the question's requirement for use of exact values was simply not understood by students. Some even quoted sin(arccos(2/3)) and then went on to use the inexact angle, gaining only 1 mark as a result.

Very few attempts at implementing Heron's formula were seen but there were a couple of excellent examples which correctly led to the exact answer.

Question 5

Some students found this one of the more challenging questions on the paper. 18.4% of the students gained no marks on this question. Conversely 33.3% gained full marks and many more answered one of the two parts completely correctly.

Part (i) was answered well by the majority attempting it, who understood what was required by the question. Most used the quotient rule correctly. Not many quoted the rule and in a few cases they quoted it incorrectly often with a sum in the numerator. Those using the product rule had mixed success often making a sign error in their expression for $\frac{dy}{dx}$. They then had difficulty simplifying their expression to obtain the required equation. The use of implicit differentiation was rarely seen.

Most of those obtaining the correct simplified derivative went on to write down the correct equation. Often those expanding $(x+1)^2$ and equating to 4, leading to a three term quadratic, solved this equation successfully obtaining two roots. Those taking the square root of both sides frequently forgot to include both positive and negative values of root 4 and so obtained just one root losing the final 2 marks. Several students unnecessarily found the *y* coordinates too.

Part(ii) was also answered well by those who attempted it. Those who split the integrand as $1 + 1/t$ then integrated and substituted the limits correctly were usually successful. However some students who reached $t/_t + 1/_t$ then failed to simplify this correctly before attempting to integrate it. The limits were used correctly by most students but errors were common trying to combine the terms $\ln 2a$ and $\ln a$, the most common being $\ln 2a - \ln a = \ln \frac{2a}{a} = \ln a$ instead of ln2. The correct answer was usually given as ln(7/2). There were some attempts to integrate the given expression using integration by parts. Very few were successful if they chose their *u* and d*v*/d*x* so that they reached a stage where the integral of ln(*t*) was required. This was often given incorrectly as $1/t$. A common incorrect answer to the integration was $(t + 1)\ln|t|$.

Question 6

25.4% of the students gained the full 8 marks on this question and over 71% gained 5 or more marks. Only 4.6% gained no marks at all.
In part (a) most students obtained the correct answer of 25e either exactly or as a decimal. A few gave the answer 25.

In part (b) many students gained 3 out of the 4 marks. Some were unable to gain the fourth mark, although a variety of successful methods were seen as well as unsuccessful "creative" ones. The algebraic stages which often led to success were either to write ln1 = lne or to write $e^{(1-10k)} = e/e^{10k}$. A common error was made by those attempting to take logs of both sides of $50 = 25e^{(1-10k)}$. This was often followed by the incorrect $\ln 50 = (1 - 10k)\ln 25$.
Most students were able to gain the first mark in part (c). Those using '*k*' in the first lines of their solution which they substituted later with the numerical value gave clearer solutions and were more often successful in obtaining the answer of 40. Those who calculated the value of *k* and worked with decimals also more often obtained 40. Others hoever were unable to carry out the correct manipulation to reach a correct expression and then value for *t*.

Question 7

Many students failed to realise that parts (a) and (b) were independently accessible and so about 40% of students earned 3 marks or fewer out of the 8 available and only 13.3% gained full marks.

In part (a) the majority of students converted at least one of the 3 trigonometric functions into a correct term containing tan. Some students attempted to change everything to be in terms of sin and cos; this was often too complicated and they made little progress. There were some issues with incorrect signs and the common errors here were :

- not knowing the expression for tan2x in terms of tanx. Just using $2t$ or $2t/(1 - t)^2$ were both quite common.
- not knowing the expression for sec$2x$ in terms of tan$x$.
- not using their new expressions in the actual equation but just stating them.

Most students who had the correct expressions managed to rearrange their expression into the required final form.

In part (b) a large number of students did not spot that the equation was a quadratic in t^2.

Many students produced this incorrect solution:
$t^2 (3 t^2 + 8) = 3$ followed by $t^2 = 0$, $t^2= 3$ or $3 t^2+ 8 = 3$ etc.
Some students reverted back to an equation containing sin and cos and spent a lot of time and effort trying to make sin or cos the subject of the equation.

A few students reached $t^2 = \frac{1}{3}$ and $t^2 = - 3$ but then failed to square root these and just went to $\tan x = \frac{1}{3}$ and $\tan x = - 3$.

Many students stopped at one solution and it was not common to see all four correct solutions in terms of π. The majority of students however who got both +/- 1/ √3 , went on to find the four solutions.

Question 8

The modal mark on this question was zero with almost 35% of the students getting no marks. Over 38% achieved at least half marks and almost 13% achieved the full 10 marks. This question provided discrimination at the A, A* level.

In part (a) it was rare to award the first method mark without the accuracy mark as students who knew the form of the differentiation, using the chain rule, could correctly find the constant multiplier too. Many students who differentiated correctly then followed this using very complicated methods involving $\sec^2 2y = 1 + \tan^2 2y$ or followed from using $\sec^2 2y = 1/\cos^2 2y$ to substituting $\cos^2 2y = 1 – \sin^2 2y$. To achieve the next method mark they needed to reach $k/(\sin 2y \cos 2y)$ and to complete this "proof" an intermediate line was required before quoting the printed answer.

In part (b) the common mistake was to separate the variables but then not link the integral to the answer from part (a). In these cases the integration often led to ln(sin4y) or ln(cos4y). Some who made the link failed to include the factor of ¼. Most attempts at separating and integrating included the arbitrary constant but for some students no further progress was possible as many students were unable to manipulate the logs/exponentials. Those students who found the constant term before eliminating the logs generally managed the manipulation better, particularly if they collected the log terms together on the left hand side first. Students who eliminated the ¼ before proceeding were usually successful.

Question 9

This question was answered well with 22.6% of the students gaining full marks. Disappointingly 12.3% gained no marks. About 65% of the students obtained most or full marks in (a) and (b), these parts being very much standard "bookwork" for parametric equations, but then either 0 or 1 of 5 marks from part (c) which required close reading and understanding in order to apply a correct method for solving a cubic with a known root. However there were a number of neat and concise fully correct solutions to (c).

In part (a) students were generally able to solve $y = t^3 - 9t = 0$, though sometimes leading to $t = 3$ without considering the negative solution. This led to $x = 15$ being obtained for point B, but the coordinates for A not being found. Some students tried to solve $x = t^2 + 2t = 0$ as well as making $y = 0$ but this often led to confusion and usually incorrect answers.

A few students differentiated x and y with respect to t in part (a) and continued incorrectly to set $\mathrm{d}y/\mathrm{d}x = 0$ to find the coordinates of A and B.

In part (b) there were many instances of full marks being awarded. The chain rule was well applied in many cases, slips most frequently being an incorrect sign (numerator or denominator) or the loss of the 'squared' in the numerator. Rarely a student eliminated t to produce y as a function of x and differentiated this. Once 18/8 or 9/4 was obtained by the substitution of $t = 3$ into their derivative, it was relatively straightforward for students to obtain the correct equation. Common errors were seen when students calculated $\mathrm{d}y/\mathrm{d}x$ correctly but then equated it to zero, or used the normal instead of the tangent gradient, or used t=0 or some other spurious value for t.

A number of scripts were seen where a gradient of 9/4 was used without any evidence of differentiation to produce the given line equation, the 9/4 clearly coming from the given equation. This was not acceptable and gained little credit. A couple of scripts were seen however where students showed that the line met the curve twice at the point where $t = 3$ and argued successfully that there was a repeated root, hence the line was a tangent at that point.

In part (c) many were successful in gaining the first M1 with a correct substitution for x and y in terms of t into the line equation but were then unable to progress as no successful attempt was made to solve the cubic equation.

Of those progressing further, most seemed to solve the cubic by using their calculator, but some showed impressive algebraic skills either by using long division with $(t - 3)$ or even $(t - 3)^2$, and less often by inspection and comparing coefficients. The students that were successful at solving the cubic usually went on to gain all marks. A few students who gave their final answer in decimals lost the final A mark for writing the coordinate as (6.56, -18.9) rather than (6.56, -18.98). Most with a correct answer gave fractions.

A common error was to take a factor of t out of the first 3 terms of the cubic [obtaining $t(4t^2 - 9t - 54) = -135$] and solve the resulting quadratic in the bracket equal to zero or even equal to -135.

There were a number of unsuccessful attempts where students equated $dy/dx = 9/4$ and solving this for t thinking this value of t would give the required x and y values. Of the students that achieved $t = -15/4$, a very few obtained an extra solution other than $t = 3$, forfeiting the final A mark.

Question 10

This was probably the most discriminating and least accessible question on the paper. Blank responses or attempts earning no marks were very common (50.3% of students). However 21.2% of the students gained the full six marks and there were some excellent clear solutions. The issues which caused the problems are summarised below.

Firstly many students did not appear to know the correct formulae for the area of a circle or volume of a cylinder. Formulae for a cone or sphere were sometimes used. It seems likely that many students were uncertain of the meaning of "area of cross-section" and allowances in the scheme were made for misunderstandings e.g curved surface area or total surface area.

Secondly although many students knew they needed to use the chain rule and quoted it correctly many failed to gain any marks owing to a raft of errors in the preliminary work where their letters for volume and area were not defined and became confused. Having said that, most knew dV/dt was required and identified that $dA/dt = \pi/20$ but this last derivative then became the value for dx/dt and was used with their dV/dx to obtain an incorrect answer for dV/dt. $dV/dA = 18\pi x^2$ was also seen frequently.

Thirdly students had problems with the differentiation of their expressions for area and volume. One common error was to fail to replace "h" in the volume formula by "$6x$" and then differentiate $V = \pi x^2 h$ treating h as a constant and obtaining $dV/dx = 2\pi xh$ or, in the case of using $A = 2\pi xh$, obtaining $dA/dx = 2\pi h$. $V=6Ax$ leading to $dV/dx = 6A$ was another example.

There were successful responses where students used $dV/dt = dV/dA \times dA/dt$. Some found dV/dA itself separately by dividing dV/dx by dA/dx rather than the direct method of Way 3 although it amounted to the same work.

Question 11

A significant group scored either no marks at all or just some of the marks for part (a) of this question, with no meaningful attempt at parts (b) and (c). 43% scored 3 marks or fewer on the whole question and only 12.3% scored 12 or 13 marks (out of 13). Some students mixed Degrees/radians throughout which made the question more difficult.

In part (a) the requirement for 3 decimal places was not always adhered to and this lost students marks. The method for finding R was well understood but for α a number of different errors occurred – giving answer in degrees was not uncommon as was taking $\alpha = \tan^{-1}(1.5/1.2)$. A few students used $\sin \alpha = \frac{1.2}{R}$ or $\cos \alpha = \frac{1.5}{R}$ to obtain R but these students often lost the accuracy mark due to a lack of accuracy to at least 3 dp. There were some responses where it was not apparent that the student was familiar with this topic at all.

Part (b) proved to be the most challenging part of the question with many students scoring no marks here. The value for H_{min} was sometimes taken to be -1.921, 4.921 and even 3. The use of $\sin(\pi/6 – 0.675) = 0$ or $\pi/6 – 0.675 = \pi/2$ were two errors seen frequently. Some understood that $\sin^{-1}(-1)$ was required but used $–\pi/2$ rather than the correct $3\pi/2$, thus losing the final A1. There were also a few attempts at differentiation which often made little progress.

A few found the maximum instead of the minimum value. Quite a few students did not answer both parts but only found a minimum value and did not attempt to find a time. However completely correct solutions were seen by the most able students.

In part (c) many students scored the first three marks. A second solution was frequently omitted in spite of the question referring to 'the times when the height . . . '. The need to give answers to the nearest minute was not always followed and many solutions were left as 2.33 and 6.24. A small number of students mistook hours and minutes and thought their answers were 2.33 minutes rather than 2.33 hours. Final answers of $t = 2$ and $t = 6$ then followed losing the final mark. Fully correct answers to this part were rare.

Question 12

This question was done very poorly indeed by the majority of students especially part (ii). There were many completely blank responses, and about 40% of the students scored zero, with a further 18% scoring just one mark. However about 34% completed part (i) with about 20% of these making some attempt at part (ii) and 9.9% scored full marks.

In part (i) if students knew how to write the coordinates of P in terms of λ then they were usually successful at completing the question, with a good proportion of those students gaining full marks. Knowing that **a.b** = 0 for perpendicular vectors was key here and seemed not to be fully understood by some students. A few of the students who knew the theory and applied it went on to make slips when solving the equation in λ so losing both accuracy marks, a common error being to find a value of 2 from the correct equation of $14\lambda = 7$.

Some did manage to write down **OP** correctly but did not know how to apply the dot product correctly, a common error being to equate each coordinate to zero, eg $-5 + 2\lambda = 0$. However, many had no idea how to start the question, not even writing down the position vector **OP** from the given vector line equation.

Part (ii) was unusual and had very few fully correct responses. Students who had success with this question usually approached it through 'Way 1'on the mark scheme using $(5k)^2 + (-3k)^2 + (4k)^2 = 2$. If a student knew the method to apply, usually a correct solution was found, the required calculations being quite simple with the (3, 4, 5) Pythagorean triple easily recognisable. Some lost the final mark because of a failure to take account of the negative square root of 1/25.

There were occasions where the correct answers were found with minimal working – a consequence of the straightforward nature of the numbers involved. Several scripts were seen where students worked out $|(5, -3, 4)| = 5\sqrt{2}$; wrote down |**OA**| = $\sqrt{2}$ and then wrote 'k' as +/- 1/5; however also seen from this work was a value of 5 leading to incorrect solutions.

A number of students who earned no marks were able to quote $x^2 + y^2 + z^2 = 2$ but got no further; some additionally found the correct dot product $5x - 3y + 4z = 10$ but this was insufficient to solve the problem.
Some students were unsuccessful as they took A to be on l_2 and some even assumed it was on l_1. But most often part (ii) consisted of a blank response, or one with nothing meaningful written down.

Question 13

Only 8.7% were able to gain full marks on this question and about 47% gained four marks or fewer.

In part (a) most were able to give the answer correct to 4 decimal places. Usually it was written in the table. Some lost the mark by rounding to 3 or even 2 decimal places.
Part (b) tested the trapezium rule. Many students scored full marks in this section. The first mark was often lost however by the incorrect value for h being found. Common errors were using ½(e^2+ e) or 1/3(e^2- e). The trapezium rule was used correctly on the whole and most students got the method mark for this. Some made bracket errors. The final answer, 2.055 was surprisingly rounded to 2.05 on a number of occasions resulting in loss of the final A mark, and completely incorrect answers to a correct written calculation were seen. Some who used $h = 2.335$ got 2.054 as their final answer.

Part (c) was frequently left out though there were a substantial number of fully correct solutions. Those who used $u = (\ln x)^2$, $dv/dx = 1$ usually succeeded in getting the first integration correct. Although many successfully then integrated ln$x$, some just writing it as a known solution, this proved a problem for some. Those who wrote $u = \ln x$, $dv/dx = \ln x$ also often got it correct, though integrating ln x often proved unsuccessful. As this was a given answer there were some cases of students trying to work backwards and filling in terms which they obviously had not derived themselves. $(\ln x)^2$ was sometimes written as $\ln x^2$ but the poor notation did not seem to affect their working and correct solutions were obtained. The notation $\ln^2 x$ was also seen sometimes. A few students successfully used substitution with $u = \ln x$, $x = e^u$.

In part (d) the majority of students got one or both of the first two marks for writing the correct expression for the volume and multiplying out $(2 – \ln x)^2$. Quite a substantial number wrote $4–(\ln x)^2$ when multiplying out and lost a method mark, but if they integrated these two terms correctly, they were able to score the following method but not accuracy mark. Another error was getting the second term as $-2\ln x$ instead of $-4\ln x$. Those who had three correct terms usually integrated each term correctly using the given solution from part (c) for $(\ln x)^2$ though some used their incorrect answer to part (c) instead of the given answer. A substantial number integrated $4\ln x$ to $4/x$, even some who had successfully integrated ln$x$ in part (c). Those who got it correct and then simplified their answer to $10x – 6x\ln x + x(\ln x)^2$ before substituting the limits were more successful obtaining the correct final answer than those who left it unsimplified. There were a substantial number of incorrect answers after correct integration due to algebraic errors and/or failing to recognise that lne = 1 and $\ln e^2 = 2$.

Grade Boundaries

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