Examiners' Report

Summer 2014

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

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Specification WMA02/01

General Introduction

In general, most students answered the paper well. The later questions provided greater discrimination, but almost all students could make a start on these questions.

Report on Individual Questions

Question 1

In Q01(a) most students were familiar with the sign change method of demonstrating the existence of a root and realised the importance of showing their working; evaluating f(1.5) and f(2) , referencing the sign change and concluding that there was a root.

In Q01(b) the iteration was well done, with very few errors.

Q01(c) caused a few more problems. A number of students who lost the A mark in Q01(a) also lost the A mark in this part for not having a clear conclusion (either no sign change mentioned or no conclusion given). Some ignored the wording of the question and continued with the iteration. Others made copying errors or misunderstood the standard form notation on their calculator.

Question 2

This question was an accessible implicit differentiation question and the majority of students performed the differentiation accurately. For those who made errors the common ones during the implicit differentiation were to omit the -1 or to write $\frac{3y\mathrm{d}y}{\mathrm{dx}}$ instead of $\frac{3y^2\mathrm{d}y}{\mathrm{dx}}$ or to leave in the -11. Some omitted the "$=0$" Many differentiated $3xy$ correctly to get $3y+\frac{3x\mathrm{d}y}{dx}$, but the minus sign caused problems whether or not the derivative was originally put into brackets.

The majority then found the equation of the tangent at the point (2, -1) without error. Some made an error at the last step when they made algebraic errors producing an equation in the required form.

Question 3

This was a short differentiation question requiring the use of the quotient rule and requiring differentiation of trigonometric functions. The quotient rule was well applied and was usually of the correct form although it was rare to see the formula quoted and/or a statement that $u=\cos 2\theta,\ v=1+\sin 2\theta$ followed by the derivatives. The most common errors were the omission of the multiplier 2 and lack of brackets resulting in sign errors. A very small minority used $uv'-vu'$ as the numerator.

Those who had a correct expression usually were able to eliminate the squared trigonometric terms. They then were able to factorise the numerator and indicate the common factor of numerator and denominator thus proving that their answer was of the form of the answer printed in the question with $a=-2$.

A small number of students applied the product rule with varying degrees of success. If they managed to differentiate correctly, many were unable to simplify the expansion using a common denominator.
The few students who tried to apply double angle formula to y before differentiating usually failed to make any progress.

Question 4

This integration question was accessible. Some omitted to include the constant of integration but were fortunate that this was not a requirement for this question.

Q04(a) was successfully completed by most students. However, there were some responses where $(2x+3)^{13}$ was correctly given but with an incorrect denominator of 13 or an incorrect coefficient of $\frac{2}{13}$. There were also some responses where students attempted differentiation.

Q04(b) was not so successfully completed and there were a few scripts where this part was not attempted and some students seemed unfamiliar with integration of the form $\frac{a\mathrm{f}'(x)}{\mathrm{f}(x)}$.

There were also many instances where the coefficient of the ln function was given incorrectly resulting in the last mark being lost. Students who took care and wrote down the substitution $u = 4x^2 + 1$ were usually successful, although some omitted to change back to the given variable. Some students lost the final mark as they failed to include the necessary brackets in their answer. There were also some attempts to differentiate by applying the quotient rule.

Question 5

This was a binomial theorem question where the power n was $\frac{1}{3}$ and the expression in the bracket was $(8 + 27x^3)$.

The majority of students used the expansion $(1+x)^n$ Most of them managed to factorise 2 or $8^{\frac{1}{3}}$ and had a good knowledge of the binomial expansion. A few students evaluated $8^{\frac{1}{3}}$ as $\frac{1}{2}$, and this could lead to the loss of the last 2 accuracy marks. Students using the notation $\binom{n}{r}$ or ${}^nC_r$ often failed to evaluate the coefficients correctly. Arithmetical errors were also seen when evaluating the coefficients. Some used x throughout instead of x^3. This was treated as a special case and they lost the last two accuracy marks. $(x^3)^2$ was sometimes expanded wrongly as x^5.

A number of students failed to multiply their correct terms by 2, or only multiplied 2 of the terms. It was rare to see students succeed with attempts at the expansion of $(a+b)^n$ as they had some awkward powers of 8 to deal with.

Question 6

There were a number of challenges in this question and it discriminated quite well.

In Q06(a) the partial fractions were done well by almost all the students. There were some errors evaluating *A* and *B* but most students gained the 3 marks. A minority of students did not write down an identity but just used the cover up rule.

In Q06(b) **s**eparating the variables was done well by most students. The majority of these integrated their log terms correctly, though some missed to divide their "*A*" by 2 on the $\ln(2x-1)$ term. Others made errors writing $(2x+1)$ instead of $(2x-1)$ The constant of integration sometimes was omitted from the general solution and this usually resulted in the last four marks being lost. Sometimes the constant was used wrongly. e.g. some wrote $y=\frac{(2x-1)}{(x+1)^3}+A$ which is not correct.

Question 7

This function question tested inverse functions, inverse functions and ranges.

In Q07(a) students were asked to find an inverse function and most were comfortable with the method and were able to find a correct answer. Many left their answer as $-\frac{x+5}{x-3}$ or $\frac{-x-5}{x-3}$ instead of the neater $\frac{x+5}{3-x}$ but this was not penalised.

Q07(b) proved challenging as they were asked to determine $\mathrm{ff}(x)$ for a rational function. Most began correctly but there was considerable algebraic skill required in manipulating the answer to its simplest form. Attempts to use a common denominator were varied. Most were correct, but a significant number of students did not multiply the constant terms by $(x+1)$. There were varied incorrect attempts to simplify the fraction. Some incorrectly expanded $-5(x+1)$ to $-5x+5$. Others multiplied both the top and bottom of $\frac{(3x-1)}{(x+1)}$ by 3. Many considered the numerator and denominator separately, simplified both and then combined.

Q07(c) was answered correctly by almost every one, with a considerable number of the students finding $\mathrm{fg}(x)$ then substituting $x=2$. Most however found $\mathrm{g}(2)=-2$ then $\mathrm{f}(-2)$ as expected.

Q07(d) gave no hint that the range would require the calculation of a minimum value. Many students realised that this was required and obtained the full 3 marks in Q07(d). This was a discriminating part of the question.

Question 8

This was a short related rate of change question which was set in context. The first two marks were fairly straightforward but there were a number of errors seen in rearranging $12000 = \frac{(4\pi r^3)}{3}$ to obtain a correct expression for the value of r. These errors included using 1200 or 120 and omitting to cube root. There were many instances where accuracy was lost by prematurely rounding the value of r to 14.

Some students applied the chain rule to find $\frac{dt}{dr}$ but then failed to invert to give $\frac{dr}{dt}$ as required by the question. A common error was omitting to square the value of r when substituting into $\frac{250}{(4\pi r^2)}$

There were a minority of students that adopted an alternative approach by writing $V = 250t$. They found r in terms of t and then differentiated with respect to t to find $\frac{dr}{dt}$ and then substituted $t = 48$. Some were able to score full marks from this approach.

Lack of accuracy often lost students the final A mark, 0.1 being a common final answer.

Question 9

In Q09(a) students were asked to use the trapezium rule with 5 strips of equal width, to calculate an area. Most did this and correctly used x values of 4, 5, 6, 7, 8 and 9. They mainly continued to obtain a correct answer and there were very few bracketing errors this time. Some however took 5 ordinates instead of 5 strips. This meant that some took $h = \frac{5}{4}$ and used appropriate x values obtaining a reasonable but incorrect estimate. Others took 5 ordinates by ignoring one of the end points and using x values of 5, 6, 7, 8 and 9 or x values of 4, 5, 6, 7, and 8. They showed understanding of the trapezium rule but used it incorrectly.

Q09(b) required calculus to find the same area. This was a question on integration by substitution which resulted in an integration by parts and was done well by a majority of the students. Most students managed to state or use $\frac{du}{dx} = \frac{1}{2}x^{-\frac{1}{2}}$ or $\frac{dx}{du} = 2u$ and obtain $2\int ue^u du$. Many did not state the rule for integration by parts and were unable to complete this integration correctly. Relatively few tried to integrate by parts in the wrong direction as this is a fairly standard integral. Several students made substitution errors at the end thus losing the final mark.

Question 10

In Q10(a) many students gained both marks by clearly showing the required result. Some omitted to mention $\sin 2A$ at all in their proof and usually gained just one of the two marks available.

There were four ways (at least) of doing Q10(b) and the most common was Way 1A on the scheme. This was the way that was expected, and many students using this method gained all four marks. Some omitted to state the $\frac{1}{\sin x} =$ in their proof and jumped from $= \frac{1}{2\sin\left(\frac{1}{2}x\right)\cos\left(\frac{1}{2}x\right)}$ to the answer. As the answer was printed this omission did not gain the final mark.

Many students began Q10(c) correctly, but some forgot to differentiate the $3\sin x$ term or made a sign error. Achieving $\sin 2x = k$ showed good understanding of this type of trigonometric question. Some students gave their final answers in degrees instead of in radians. The squaring method was rare but was completed by some students.

Question 11

In Q11(a) most students realised that they needed to differentiate but the *a* caused some problems and a significant minority tried to use a product rule on the first term. Those who differentiated correctly put their derivative equal to zero but sometimes made incorrect ln statements as they tried to find the value of *x*. A number of students forgot that both coordinates were required here and so they did not gain the last two marks in this part.

Q11(b) was found to be challenging and displayed weak understanding of the log rules. There was more difficulty here as the method of equating powers was not possible, due to the factor '3' and very few knew how to deal with $3\mathrm{e}^{-x}$. Those students who had used $1 = \mathrm{e}^{a-2x}$ in Q11(a) applied the same technique successfully. The best answers split the e^{a} and converted e^{-3x} and e^{-x} to reciprocals, making it easier to see the need to multiply by e^{3x}. Many answers became $-3x$ on taking logarithms and there were many solutions where $3\mathrm{e}^{2x}$ became $\left(\mathrm{e}^{(2x)}\right)^3$. Almost all who obtained the second M mark also went on to gain the A mark. Those who were successful could give their answer in a number of correct forms. e.g. $x = \frac{a - \ln 3}{2}$ or $\frac{1}{2}\ln\left(\frac{\mathrm{e}^{a}}{3}\right)$ or $-\ln\sqrt{\left(\frac{3}{\mathrm{e}^{a}}\right)}$

Q11(c) was the graph of a modulus function and was answered well. The graph shape was usually correct with a clear cusp. The intersection with the *y* axis was frequently omitted however so 2 out of 3 marks was common here.

Question 12

This was an integration question testing volume of revolution, parameters and trigonometric functions. The proof element of this question was one of the more demanding sections of the paper.

In Q12(a) students were asked to show a printed answer for 6 marks. The first mark required them to show where the limits had come from and most did this clearly, but a minority omitted to show evidence of changing the limits from *x* to *t*. They then had to use the formula for volume using their parameters and most were able to reach $(\pi)\int(2\sin^2 t)^2 \sec^2 t\,\mathrm{d}t$. There were a number of ways of proceeding from this point towards the printed answer but only the better students were able to do this efficiently. Many students just wrote down the answer without showing where it had come from.

In Q12(b) students who were able to recall their trigonometric identities correctly were usually able to make good progress and there were a number of cases where full marks were awarded. However, many students used incorrect identities for $\sec^2 t$ and $\sin^2 t$ (usually involving sign errors). Students should always be encouraged to write down identities before proceeding to rearrange them. Errors also occurred when brackets were omitted eg $\sin^2 t = \frac{1}{2} - \cos 2t$. Another common error was failure to give a simplified 2 term exact answer and those who gave their final answer as a decimal, with no exact equivalent, consequently lost the final mark.

Question 13

In general this question was found to be challening.

Q13(a) was done very well with most students obtaining the full 3 marks. Some failed to find *R* in Q13(a) as required. Of the majority who found *R*, it was rarely found incorrectly. The most common form was the exact form of root(5), with 2.24 seen in a significant minority of cases. Alpha was found correctly for the most part, but could be incorrectly rounded to 26.6 or 26.56, and occasionally 0.46 radians.

Q13(b) was frequently omitted. Many did not realise that they should be using the distance between the two parallel lines. Among those who did show some understanding of what was required, diagrams and clear explanations of their reasoning were rare. However, the best answers were encouraging as they used the given drawing or, even better, drew the triangles they were using and labelled all sides and angles used in their solution.

Q13(c) was usually well answered. Most used the first method on the scheme and used their answer from Q13(a). However this did not always lead to a correct answer due to rounding errors resulting from R=2.24 or an incorrectly rounded alpha. There were a significant number of students who did not recognise the need to use their Q13(a) answer. These students often generated much incorrect work which did not result in a correct answer. It was interesting that students who mistakenly had alpha to be arctan(2) in Q13(a) then obtained a zero, or close to zero value for theta here, but usually did not question this answer at all.

Q13(d) was also frequently omitted. However those attempts seen were generally correct with 1.3 being the most common answer, although some gave the exact answer of $\frac{4}{3}$. There were a number of ways of finding the value of the overlap *h*, some quite long and indirect, and it was not always clear what the student was doing as explanations were not always clear. There were a number of basic trigonometric errors e.g. using sin instead of tan. A number of correct solutions were seen using the sine rule in a right angled triangle.

Question 14

Q14(a) was done well by most students. The most common error was to use the same value of λ, usually 1, for both *a* and *b*.

Q14(b) was accesible and there were many correct answers. Even those students who found the wrong answers to Q14(a) almost always scored the method mark here. Very few students added the two vectors.

Q14(c) needed the vector **AC** or the vector **CA**. Those who realised this usually found the correct scalar product and then the correct angle. Some students changed a negative to a positive to falsely give the answer of 30^0 resulting in the loss of the final A1. Others were using completely the wrong triangle which indicated a lack of understanding. Only a few students used the cosine rule for this part of the question.

Q14(d) needed to be the area of the correct triangle and a correct attempt at Q14(c) was usually followed by a correct attempt Q14(d). Many achieved $k = 3$, though some students forgot to multiply by $\frac{1}{2}$ in theory calculation.

In Q14(e) the information was presented as a relationship between areas of triangles. Only a small number of students realised that this implied a relationship between the bases of those triangles as they had the same height. There were a few short efficient answers which showed thorough understanding and there were longer answers involving quadratics which eventually yielded the answer too. The latter algebraic approach usually included no diagram and errors were not always picked up by students. These errors included using *AD* is half *AB* instead of double *AB*. Some even used *AD* is equal to *AB*. This gained no credit as their *D* ended up as having the same coordinates as *B* which should have alerted the students to their error.

Grade Boundaries

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