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Examiners' Report

Summer 2016

Pearson Edexcel IAL in Further Pure Mathematics 3 (WFM03/01)

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IAL Mathematics Further Pure 3
Specification WFM03/01

Introduction

Most students could find plenty of opportunity to demonstrate their knowledge in this paper. There were no obvious signs that students did not have sufficient time to complete all the work they were able to do.

Students should be advised to write down the formula that they are going to use. Errors in substitution are then penalised by accuracy marks only; if the general formula is not shown then method marks are lost as well and if dependent method marks follow then the omission can cost them several marks.

It was sometimes difficult to distinguish between powers and multiples in some students' presentation.

Report on Individual Questions

Question 1

This question was found to be accessible. Most students could differentiate correctly although there was the occasional student who thought that $\cosh x$ differentiated to $-\sinh x$. There was also the occasional error in signs for the expression of $\sinh x$ and $\cosh x$ in terms of e^x and e^{-x}. Most then realised they needed to rearrange their expressions to obtain a quadratic in e^x and were able to solve their quadratic correctly although the occasional one had incorrect signs. Most realised that they should only chose the positive value for e^x and then got the correct answer although some still wrote $x = lm\left(\frac{-3}{2}\right)$ which does not exist as well as the correct answer. Very few used the alternate method of squaring and attempting the quadratic in $\cosh x$ but most who used this method got to the correct answer although again some had $\cosh x$ as negative which is not possible.

Question 2

Most got Q02(a) fully correct although the occasional student lost an x somewhere in the middle but "found" it again at the end as the answer was given.
In Q02(b) most correctly found the coordinates of *Q* and many then went on to find the coordinates of *M* although some made errors in calculating the *y* coordinate. There were then many different ways of finishing the question. The first method was to find the coordinates of the point (which can be called *L*) where the line given in Q02(a) cuts the *x*-axis and then find the areas of the triangles *OPL* and *OML* and add them together. Alternatively some used the determinant method to find the area of the triangle required. The next method did not need the coordinates of *M* but used triangle *OPQ* and then used the fact that area of triangle *OPM* was half of this due to the fact that distance $PM = \frac{1}{2} \times$ distance QM – this was quite popular. Very few used the method of finding distance *OP* and then the distance from the point *M* to line *OP*. The most common error was to work out the area of triangle *OQM* but not explain why this area was the same as area of triangle *OPM* (due to distance *PM* = distance *MQ*)

Question 3

Q03(a) was usually correct, even if some students made life difficult for themselves by using the substitution $x+2=3\tan t$ rather than quoting the standard integral result.
The $4x^2$ in Q03(b) proved to be much more of a problem. Many simply divided the whole expression by 4 and integrated $\dfrac{1}{\left(x-\frac{3}{2}\right)^2+\frac{25}{4}}$. Those who completed the square correctly to get $(2x-3)^2+25$ then often lost the necessary half on integration.
Use of limits and logarithmic form were usually correct but those who tried to rationalise the denominator within their logarithm quite often failed to do so correctly.

Question 4

Most students got Q04(a) fully correct. Some students made errors in forgetting to change the signs in the matrix of cofactors or finding some signs correctly and not others. The occasional student found the wrong determinant again by a sign error.
In Q04(b) most students realised that they had to work out $M^{-1}N$ and many correctly used their answer to Q04(a) in this respect. There were many fully correct answers. The major error was in calculating NM^{-1} rather than the correct matrix product. However there were some who, having the correct matrices and trying to calculate the correct matrix product, made arithmetic errors usually with multiplying two negative numbers.

Question 5

Q05(a) was generally well done by the majority of students. Most students used the chain rule directly, some used the substitution $u=\cos x$ and correctly obtained the given result. Other students rearranged to get $\tanh y=\cos x$ and differentiated implicitly though, and while a few did not substitute for $\text{sech}^2 y$ to obtain an expression in x, most were able to rearrange to obtain the given result, showing all the necessary steps in their working.
Many excellent solutions were seen to this part of the problem. Some students tried to use integration by parts in the wrong direction and made no progress. They seldom realised the need to restart with $"u"=\text{artanh}(\cos x)$ and $"\frac{dv}{dx}"=\cos x$. The most common error here was to lose the factor of $\frac{1}{2}$ when using the ln form of artanh x. This happened most frequently when students tried to miss lines of working and jump directly from their integral $\left[\sin x\,\text{artanh}(\cos x)+x\right]_0^{\frac{\pi}{6}}$ to substituting the limits and writing in the ln form in a single step.

Question 6

In Q06(a) students were unfamiliar with the method for finding an equation of a plane. The most popular approach was to find the normal vector to the plane using a vector product. A number of solutions proceeded using coordinates of two points rather than two vectors in the plane. The method for finding the constant in the plane equation was generally well known. There were many completely correct solutions but an answer of $\mathbf{r}.\begin{pmatrix}4\\7\\1\end{pmatrix}=21$ was seen on a number of occasions. A few solutions used their normal vector to write down the equation of a line and some students misunderstood the meaning of "Cartesian" and proceeded to write down an answer in the form $\mathbf{r}=\mathbf{a}+\lambda\mathbf{b}+\mu\mathbf{c}$

For Q06(b) many attempts to find the volume of the tetrahedron were made using a vector **OD** rather than **AD** (or equivalent). Use of a triple scalar product was well recognised. A few students did not recognise they already had a normal vector and repeated their working. The need for a factor of $\frac{1}{6}$ was occasionally forgotten. Errors in finding a value of *k* included $\frac{1}{6}\times(4k+21)=6$ implies $4k+21=6\times\frac{1}{6}$ and a lack of recognition that the question said that *k* had to be positive.

Question 7

The derivatives in Q07(a) were almost always correct, though a few students got no further than this. The majority quoted/ used a correct formula, though it occasionally lacked a y. Those who used $\sqrt{1+\left(\frac{\mathrm{d}y}{\mathrm{d}x}\right)^2}$ managed to negotiate their way to the required form. Successful factorisation usually followed, so it was usual for those who progressed beyond the basic derivatives to score full marks.

Puzzlingly in Q07(b) $u^2 = t^2 + 1$ sometimes led to $t^2 = u^2 + 1$. Other than this, differentiation was, again, usually correct though very complicated versions resulting from $u = (t^2 + 1)^{\frac{1}{2}}$ or $t = \left(u^2 - 1\right)^{\frac{1}{2}}$ were common. It was no surprise that substitution of "dt" caused problems either by being upside down or by being simply changed to "du", but a significant number successfully completed to the correct integral in terms of u. From here, some used integration by parts and were occasionally successful, while those who tried to expand and integrate were sometimes puzzled by the u^2 in $\left(u^2 - 1\right)^2$. New limits were usually found correctly but the bottom one seemed to revert back to 0 from time to time.

For those who had navigated everything else successfully, the final hurdle was to factorise their expression to the required form. As with Q03(b), there was often a lack of appreciation that we can't simply multiply/divide at will when an expression does not equal 0, so it was quite common to simplify the fractions by multiplying by the common denominator.

Question 8

Many students found Q08(a) of this question challenging. There were many cases where Q08(a) or the whole question was not attempted. There were also many cases of students trying to integrate in Q08(a) by first writing $\tanh^{2n}x$ as $1\times\tanh^{2n}x$ or $\tanh^{2n-1}x\tanh x$. The cases of it being written $\tanh^{2n}x = \tanh^{2(n-1)}x\tanh^2 x$ were in the minority. In the main students who started off by using one of the incorrect expressions did not go on to try an alternative. Of those students who did write $\tanh^{2n}x$ as $\tanh^{2n}x = \tanh^{2(n-1)}x\tanh^2 x$ some then made no further progress. Many did substitute $\tanh^2 x = 1 - \mathrm{sech}^2 x$ and split their expression into 2 integrals, however they then did not recognise this as the derivative of $\tanh^{2n-1}x$ and tried to integrate $\tanh^{2n-2}x\,\mathrm{sech}^2 x$ by parts. While, of course, this is possible many mistakes occurred on the way.

Attempts at Q08(b) were much better and there were many students who were unsuccessful in Q08(a) who went on to complete Q08(b) with full marks. The most common errors here were using $n = 4$ rather than $n = 2$ and sign errors if students calculated I_1 rather than I_0.