Examiners' Report

Summer 2014

Pearson Edexcel International Advanced Level in Further Pure Mathematics F2 (WFM02/01)

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General Introduction

This was a paper with some accessible and challenging questions thus every student was able to show what they had learnt.

Report on Individual Questions

Question 1

This question was successfully attempted by the majority of students, with most adopting a partial fractions approach to Q01(a) and attempting to write the left hand side as a sum or difference of two or three fractions. Many variations were seen, with those students who used the given right hand side to produce two fractions with denominators $2(r+1)(r+2)$ and $2(r+2)(r+3)$ generally more successful. Of those students who attempted to find three partial fractions, although the majority successfully found the numerators, many did not produce adequate evidence to progress from this to the given result. Writing $\frac{1}{2(r+1)}-\frac{1}{(r+2)}+\frac{1}{2(r+3)}$ and moving straight to the printed result without splitting the middle term and combining to two terms was an incomplete method and so was awarded no marks.

Surprisingly few students took the simpler route of combining the RHS over a common denominator, but where this approach was used it almost invariably led to a correct result.

Q01(b) was well attempted, with many students scoring all the marks. Most were able to write the first and last pairs of terms and use a method of differences to eliminate terms resulting in two correct fractions. Where errors were seen, these were usually a failure to combine the remaining two fractions or manipulation errors when attempting to do so.

Question 2

This question was attempted well, with many students scoring 6 or 7 marks. By far the most common error was an inclusion of an = on the upper limit of 3 in the inequality $-3 \leqslant x < 3$.

Most students used a valid approach, usually multiplying both sides by $(x-3)^2$ or combining terms on one side as a single fraction to obtain correct critical values. Where students multiplied by $(x-3)$ it was rare for them to state that $x-3>0$ and marks were lost as a consequence. Whilst most students successfully identified all three critical values, there were errors in identifying the required solution, with direction and = errors on the inequality signs. Many students supported their solution with a sketch of the cubic.

Question 3

Most students obtained a correct value of 2 for *r* (although this was often not seen until the final line) and an argument of $\frac{5\pi}{3}$ or $\frac{-\pi}{3}$, although $\frac{\pi}{3}$ was seen frequently. Significantly fewer students were able to apply $\arg z + 2n\pi$ to find four positive answers, with many providing one or two correct solutions, but often including a mixture of positive and negative exponents.

Question 4

This question was well attempted, with most students successfully rearranging the given equation to express z in terms of w, although sign errors were not uncommon here. Most students recognised the need to apply Pythagoras to form an equation in u and v or x and y and went on to produce a fully correct solution. However, errors in application were seen, most commonly a failure to square a coefficient of 3 in $3w$ or 2 in $2(1-w)$. Despite this, many were still able to form a circle equation and gain the method marks although some could not complete the square correctly and so did not obtain the correct radius.

Question 5

Most students could differentiate correctly, applying the product rule twice to produce expressions for y''' and y''''. Those who did not notice that the third differential simplified often got into difficulties on attempting the fourth differential. Although most then went on to use these two results to reach a result in the given form, errors were seen at this stage, or it was omitted altogether. Most students then went on to use their expressions for y', y''' and y'''' to find values at $x = 0$ and substitute into an appropriate MacLaurin expansion, finally going on to substitute $x = -0.2$ and produce a correct answer, although some numerical and algebraic errors were seen. It was not uncommon to see students substitute $x = 0.2$ and so score zero in Q05(c).

Question 6

Some students forgot to divide the right hand side by x, leaving it as x while others forgot to multiply their integrating factor on the right hand side and so integrated 1. However most students were able to determine an integrating factor of $\mathrm{e}^{\ln x - 2x}$, but some students could not get any further. Most who got this far were able to write their integrating factor as $x\mathrm{e}^{-2x}$ and multiply through to produce a correct statement involving $\int x\mathrm{e}^{-2x}\mathrm{d}x$. Most students then attempted integration by parts, many correctly, but errors were often seen here, mostly in the form of incorrect coefficients. Those students who obtained an integrating factor which did not give rise to an integral that required integration by parts could gain no further marks. Students who got as far as an expression which was the result of an integration usually completed the final step to gain a general solution for y which included a constant although a few incorporated e^{2x} into the constant, creating a new "constant".

Question 7

This question was usually attempted well, with most students able to apply Pythagoras to form two equations in x and y or u and v. The use of w seemed to cause students to think of a transformation and so the most common approach was to use x and y for the first and u and v for the second. Many students did not subsequently make it explicit that at the point of intersection they should just be using one pair of variables. A small minority of students were able to write down directly that the locus of Q was the perpendicular bisector of (0,0) and (1,-1) and write it as $y = x - 1$.

Some numerical and manipulation errors were seen, as well as errors in applying Pythagoras, most commonly a failure to square a coefficient or errors arising from attempted factorisation before squaring, but most students were able to find two values for x or y by solving their quadratic. All but a small minority then found the corresponding value to complete the coordinate pair and solutions were usually identifiably paired. A common error was to change $2y - 2x + 2 = 0$ to $y - x + 2 = 0$.

Question 8

Many different approaches were used in this question, with most students able to gain some, or all, of the marks. Almost all students were able to apply the chain rule to obtain a correct first derivative and most then attempted to find a second derivative. Many errors were seen here, with some students failing to use the product rule and others incorrectly applying the chain rule or neglecting it altogether. Students who did achieve an expression for a second derivative were then usually able to substitute this and their first derivative into the given differential equation to achieve the printed result. This could take many forms, including combinations of terms in x and e^t. Some students did work from the second differential equation to the initial one and provided the work was correct this was equally acceptable.

Almost all students could form an auxiliary equation and solve it to obtain two complex roots. Most then used these to give a correct general solution, although a significant minority gave it in terms of x or even θ instead of t. Although some students stopped at this point, most then replaced t by $\ln x$ and gave a correct general solution. Those who had given the general solution in terms of x thought they had finished and so did not reverse the substitution.

Question 9

Q09(a) was completed well, with the vast majority of students able to give both sets of coordinates. A small minority gave their answers in the form (θ, a) or neglected to write them as coordinate pairs having found values for θ.

In Q09(b) most students identified the need to integrate $(2a\sin 2\theta)^2$, and most then applied a correct identity to replace $\sin^2 2\theta$ with $\frac{1}{2}(1-\cos 4\theta)$, although many incorrect identities were attempted. Where a correct identity was used, integration was usually carried out resulting in $\theta - \frac{1}{4}\sin 4\theta$ although coefficient errors were not uncommon. Many students were unable to identify the correct limits required to evaluate the required area *R*, with many attempting an integral between the two values found in Q09(a), $\frac{\pi}{12}$ and $\frac{5\pi}{12}$, and failing to evaluate the area of the sector anywhere in their solution.

Grade Boundaries

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

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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