Examiners' Report
Principal Examiner Feedback

October 2021

Pearson Edexcel International Advance Level
In Further Pure Mathematics F2 (WFM02)
Paper : WFM02/01

General

This was a paper that contained a good mix of questions that followed a predictable form and some that were unexpected, particularly questions 6(b) and 9(b). In the case of 9(b) it was impossible to know whether the large number of poor or blank responses was due to lack of tine or an inability to solve the problem.

As usual there were many candidates who failed to give sufficient evidence when dealing with "show that" questions.

It is disappointing to see Further Mathematics candidates giving rounded decimal answers when exact answers should have been supplied. Examples were seen in the Taylor's series (question 5) and the centre of the circle (question 6). The circle with centre 4.24 is smaller than the circle with centre $\sqrt{18}$.

Report on individual questions

Question 1

This was a very accessible first question, but a significant number of candidates were unable to score anything other than the mark for $r = 2$. Some were unable to correctly identify a correct argument for 32i and therefore unable to access the second two marks. Most students who identified the correct strategy and obtained a correct argument followed on to get full marks though some only gave 4 solutions.

Question 2

Most candidates applied the alternative method of multiplying by a positive expression, namely $x^2(2-x)^2$. Those collecting to one side and creating a common denominator were equally as successful. Very few candidates tried to use a fully graphical method and a few candidates erroneously cross multiplied by x and $(x-2)$. Many candidates were able to identify the first two critical values and also go on to solve a 3TQ to obtain the other two critical values. It was surprising how many candidates were unable to form the correct inequalities, even though they had found the correct critical values. Not surprisingly, a smaller group were able to achieve the correct strict inequalities by recognising that x cannot be 0 or 2 thereby gaining the final A mark.

Question 3

The most common way of approaching this question was for candidates to rearrange the given transformation to make z the subject, and then multiply by the conjugate of their denominator. Most candidates who got this far were at least able to set their real part equal to 0. However, some candidates seemed perturbed by the resulting algebra and made no further progress. It was common to see incorrect responses attempting to multiply by the conjugate of $w - 2 - \mathrm{i}$ without introducing real and imaginary parts, or indeed to begin by multiplying by e.g. '$z + \mathrm{i}$'. It was evident that these candidates had had very little practice of this type of question and had no real understanding of what a conjugate was. Very few candidates attempted to use 'way 2' in the solution, but those that did were usually able to accrue at least the first three marks, with the resulting algebra proving challenging. It was rare to see a candidate attempt a solution using 'way 3' on the mark scheme. This was disappointing as it was a simple and elegant solution.

Question 4

This question proved a real challenge for a significant number of candidates. Virtually all were able to obtain the first B mark for arranging the given differential equation into the correct form. However, the integration of $-\frac{x}{x+1}$ needed for the I.F. proved elusive for many, with 'guessed' solutions of $-xln(x+1)$ etc seen frequently. It was clear that some candidates' basic A level integration was not up to the standard required for a further mathematician. It was very common to see candidates attempt this integration by using substitution, and this led to a correct I.F. form if followed through correctly, and a 'c' value of $\frac{9}{2\mathrm{e}}$ which gave the correct final result. Some candidates attempted to use integration by parts but hardly any were successful. It was interesting to see that some candidates insisted on persevering with e and ln their terms until the end of their integration, instead of simplifying the I.F. first and then multiplying by a simpler function. Some candidates multiplied only one side of their equation by the I.F. but it was rare to see no attempt at $yI = \int QI \, \mathrm{d}x$.

Question 5

Part (a) of this question was successfully answered by most candidates and many fully or nearly fully correct solutions were seen. Almost all candidates obtained the first mark for the first derivative, and it was rare to see conversion to sine and cosine terms first. Some complicated solutions were seen involving the quotient or product rule but they were rare. Most decided to differentiate for a second and a third time using the chain and product rule for sec and tan. It was rare to see the second derivative simplified before differentiating for a third time. The last mark in (a) proved elusive for many, with some unable to recall the correct identity needed to obtain the correct form for the final answer.

Part (b) again proved accessible to many, with most candidates able to evaluate values up the third derivative and apply them to a correct Taylor series expansion. Some could not evaluate these as exact values and appeared to be using their calculator in degree mode. The final A mark was lost with some due to poor notation' labeling or using rounded values. Some lost 2 marks as they did not quote a correct formula and made errors when substituting. Failing to attempt to calculate the third derivative resulted in no marks.

Question 6

Part (a) of this question was problematic for many students. Most understood the method and applied Pythagoras' theorem correctly, however there were many algebraic mistakes after this, resulting in incorrect centres and radius.

A significant number of candidates did not know how to approach part (b). Many of those who were able to find the correct Cartesian equation for the argument were then able to solve this equation simultaneously with their circle equation. Some candidates did not appreciate that only one of their resulting solutions actually fitted the given information and so lost the final mark.

Question 7

In part (a) the vast majority were able to use the chain rule to find $\frac{dy}{dx}$ but finding the second derivative was not so successful, with many using the product rule but using the chain rule incorrectly or not at all. As this was a 'show that' question, many students attempted to amend their second derivative to make the 'show that' work, usually unsuccessfully. Some students did not show the full substitution but instead followed an equation with 3 variables with the final answer. Possibly they thought their equation was incorrect due to an earlier error and hoped the examiner would not notice.

Part (b) was very well answered. Most were able to write the C.F. although some forgot they were solving an equation in t at this point and used x instead. The majority realized their error when they formed the G.S. and so gave the correct G.S. There were many errors solving the equations to find the P.I., which is disappointing at this level. Some incorrect forms for the P.I. were seen.

The mark in part (c) was gained by most candidates who were able to convert their G.S. from (b) into a correct equation in x.

Question 8

Many fully correct solutions were seen for part (a). Some candidates attempted to differentiate $y = r \sin\theta$. When θ was found, most candidates remembered to find the value for r.

A significant number of candidates did not attempt part (b), even though they may have gained full marks for part (a). Those who did applied the correct integral and were mostly able to correctly use the double angle formula to achieve the correct integration. A significant number who had correctly calculated the angle in part (a) failed to use it as the lower limit in the integral. Only a minority of candidates was able to identify and correctly calculate the area of the trapezium and hence were not able to access the last three marks. Few fully correct answers were seen.

Question 9

Almost all were able to expand $(n - 1)^5$ for part (a), with many using Pascal's triangle successfully to expand effectively. In these "show that" questions, candidates must remember to show full solutions, including how they obtained the expansion.

Many candidates were unable to make any sensible start to solve the problem in part (b). Those who did realise what the question was asking for were able to introduce the summation formulae correctly and attempted to factorise to the given form. Some made sensible use of the printed answer by dividing their expressions by the linear factors shown. However, the vast majority failed to gain any marks at all.