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General Certificate of Education

Mathematics 6360

MFP3 Further Pure 3

Report on the Examination

2007 examination - June series

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General

Presentation of work was generally good and candidates usually answered the questions in numerical order. Candidates appeared to have sufficient time to attempt all the questions within the time allowed.

Candidates generally scored very high marks for the first three questions on the paper but found the last two questions more of a challenge. Although there were again many excellent scripts, the proportion of candidates scoring 70+ marks was significantly lower than last year.

Once again, many candidates failed to complete the boxes on the front cover to indicate the numbers of the questions they had answered.

Teachers may wish to emphasise the following points (some of which have been highlighted in previous reports) to their students in preparation for future examinations in this unit:

- Just listing values in a well-labelled table to solve a differential equation numerically eliminates the possible awarding of method marks if the values are incorrect. Candidates would be well advised to indicate, by showing the relevant formulae and substitutions into them, how the values in the table have been obtained.

- Writing down a formula in a general form before substituting relevant values may lead to the award of method marks even if an error is made in the substitution.

- Where candidates offer two equally full solutions to a question without deciding and indicating which one is to be marked, they will have both solutions marked and the mean mark, rounded down, will be awarded. Candidates rarely gain by not making such a decision themselves.

- The general solution of a second-order differential equation of the type shown in question 1 should be given in the form '$y = \mathrm{f}(x)$', where $\mathrm{f}(x)$ contains two arbitrary constants.

- Candidates must show all necessary working, especially in questions where they are asked to show a printed result or, as in the polar coordinates question (question 4), where errors in integration methods still lead to the 'correct' value for an area. Candidates who fail to show necessary working can lose a significant number of marks.

Question 1

Many candidates gained very high marks for this opening question which tested the solution of a second order differential equation. In part (a), although the form of the particular integral was given in the question, a significant minority of candidates preferred to discover it themselves and tried particular integrals $y = a\mathrm{e}^{5x}$ and $y = ax\mathrm{e}^{5x}$, showing that each failed before trying $y = \mathrm{a}x^2\mathrm{e}^{5x}$ and finding that $a = 3$. These candidates were not penalised for this approach but clearly they used up valuable time in doing more than what was required. Some candidates also found the complementary function in part (a) and full relevant credit was given even if this work was not repeated in part (b). Most candidates indicated that they knew how to find the complementary function and how to use it to find the general solution but a significant number failed to score full marks because they did not give their final answer in the form '$y = \mathrm{f}(x)$' where $\mathrm{f}(x)$ contains two arbitrary constants.

Question 2

This question which tested numerical solutions of differential equations was answered well with a large proportion of candidates gaining full marks. The most common error was the use of 2.1 instead of 2.2828... in finding k_2. Although there were again candidates who failed to show working (by writing down the correct formula and then substituting in the correct values), the proportion doing so was significantly less than last year. The vast majority of candidates gave their final answers to the required degree of accuracy but more should be encouraged to show intermediate answers to more than the stated degree of accuracy.

Question 3

This question on solving a first-order differential equation by use of an integrating factor was the best-answered question on the paper. Only a few candidates failed to find a correct integrating factor; such candidates failed to realise that the integral of $\tan x$ is available from the AQA formulae booklet. The most common errors were forgetting to multiply the right-hand side of the given differential equation by $\sec x$, or rearranging '$y \sec x = \tan x + c$' incorrectly as '$y = \tan x \cos x + c$' before substituting the given boundary conditions.

Question 4

A very high proportion of candidates showed knowledge of the two trigonometric identities required in part (a). Part (b) was also answered correctly by many candidates although the errors '$x^2 + y^2 = r$' and '$\left(r^2\right)^3 = r^5$' were not uncommon. Most candidates scored at least two of the three marks in part (c)(i), with some losing the final mark for either the wrong value $\frac{\pi}{4}$ or for giving their second value outside of the stated domain.

In the final part of the question, it was pleasing to find most candidates stating the general formula for the area of a sector in polar coordinates (as given in the AQA formulae booklet) and then substituting and expanding for r^2 correctly. It was pleasing to see a large number of candidates write $\sin^2 2\theta$ correctly in terms of $\cos 4\theta$ although, for others, all the usual errors were presented, many of which led to the 'correct' value $\frac{3\pi}{4}$ for the area of a loop. Although many candidates correctly used their values obtained in part (c)(i) for the limits of integration, some used different values without any explanation or justification. A very small number of candidates did not show their method of integration in reaching the answer $\frac{3\pi}{4}$. Such candidates lost the same significant number of marks as those who, for example, used the wrong identity '$\sin^2 2\theta = \frac{1}{2}(1 - \sin 4\theta)$' to integrate $\frac{1}{2}\left(1 + 2\sin 2\theta + \sin^2 2\theta\right)$ and obtained the answer $\frac{3\pi}{4}$.

Question 5

This structured question tested the solution of a differential equation of the form $\frac{d^2y}{dx^2} + P\frac{dy}{dx} + Qy = R$, where P, Q and R are functions of x; a topic introduced to the specification for the first time in 2007. Part (a) was usually answered correctly although some candidates, who 'obtained' the printed answer, had made earlier errors in their algebraic manipulation. Such candidates would have scored better if they had looked for their first error rather than making a second error to obtain the printed result.

Most candidates who attempted to solve the first-order differential equation in part (b) by separating the variables were successful in obtaining the first four marks, but the last mark was frequently lost as the candidates often rearranged their solutions to give $u = x^2 - 1 + A\frac{\mathrm{d}y}{\mathrm{d}x}$ rather than $u = A\left(x^2 - 1\right)$. Those candidates who attempted to solve the differential equation using an integrating factor were often unsuccessful due to integrating $\frac{2x}{x^2 - 1}$ rather than $-\frac{2x}{x^2 - 1}$.

Those candidates who obtained an answer for part (b) usually scored the first mark in part (c) for forming a first-order differential equation in y and x, but a significant proportion then failed to gain any further marks as their general solution to the second-order differential equation did not contain two arbitrary constants.

Question 6

Many candidates, including those who had scored almost full marks on the previous five questions, failed to score many marks on this question. In part (a), a minority of candidates attempted to use series expansions instead of the prescribed Maclaurin's theorem. Although a special case was allowed, with a significant reduction in available marks, very few of these candidates scored any of them. For those using Maclaurin's theorem, most scored the first mark for finding $\mathrm{f}(0)$ but a large number of candidates failed to use the chain rule and differentiated $\ln(1+\mathrm{e}^x)$ incorrectly as $\frac{1}{1+\mathrm{e}^x}$. Some of these candidates 'recovered' to score the next method mark but others just continued incorrectly to give subsequent derivatives in the form $(1 + \mathrm{e}^x)^n$. Part (b) was not answered well, the most common error being illustrated by '$\ln\left(\frac{1+\mathrm{e}^x}{2}\right) = \ln\frac{2}{2} + \frac{1}{2}\left(\frac{1}{2}x\right) + \frac{1}{2}\left(\frac{1}{8}x^2\right) = \frac{1}{4}x + \frac{1}{16}x^2$'. Most candidates gave the correct answer for part (c) and in part (d) a significant majority of candidates scored at least half the marks. Some candidates failed to use sufficient terms in the series expansion of $\sin x$.

Question 7

The standard result required in part (a) was known by most candidates. In part (b), a minority of candidates failed to use the given substitution and a significant minority of others left their final answer in terms of u. In part (c) it was not always clear to the examiners that a candidate had fully seen the relationship between the integrands in parts (b) and (c). Some candidates clearly showed the relationship by multiplying both the numerator and the denominator of the integrand in part (c) by e^{-x}. Sometimes poor use of brackets led to the wrong answer '2' presumably from $-\ln \mathrm{e}^{-1} + 1$. However it was pleasing to see the increased number of candidates who correctly used the limiting process this year.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the **Results statistics** page of the AQA Website.