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Mathematics MFP3

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Further Pure 3

Report on the Examination

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General

There were many excellent solutions seen and a large proportion of candidates seemed to be thoroughly prepared for this examination. Presentation of work was generally good and most candidates completed their solution to a question at the first attempt. Almost all candidates appeared to have sufficient time to attempt all seven questions. Questions 1, 2 and 4 were the best answered questions on the paper and there was no part of any question on the paper which caused the better candidates any serious difficulty.

Teachers may wish to emphasise the following points to their students in preparation for future examinations in this unit:

- Writing down a formula in a correct general form before substituting relevant values may lead to the award of method marks even if an error is made in the substitution.
- Explicit and careful consideration should be given to $\lim_{x\to\infty} x^k \mathrm{e}^{-2x}$ and $\lim_{x\to 0} x^k \ln x$, for $k > 0$, in any question where these limiting values are involved.
- A general solution to a second order differential equation should have two arbitrary constants.

Question 1

Numerical solutions of first order differential equations continue to be a good source of marks with most candidates showing full working with clear substitutions into relevant formulae. Unfortunately, more candidates than usual made arithmetical errors in calculating the value of k_2. Very few candidates failed to give their final answer to the specified degree of accuracy.

Question 2

Most candidates were able to find the correct values of the constants p and q so that the given expression was a particular integral of the differential equation. An even higher proportion of candidates scored full marks for their general solution in part (b) as examiners allowed follow through on incorrect values for p and q. However, less than 20% of the candidates scored full marks for their answers to part (c). This was almost entirely due to no explicit consideration being given to the value of $x\mathrm{e}^{-2x}$ as $x\to\infty$. More surprisingly, a significant minority of candidates could not correctly deal with the boundary condition $\frac{\mathrm{d}y}{\mathrm{d}x} \to 0$ as $x\to\infty$ as they had an e^x term in their final answer.

Question 3

Part (a) was, as expected, very well answered with candidates clearly showing the method of integration by parts. In part (b), a significant number of candidates were not explicit in explaining that the integrand was not defined at $x = 0$. It was pleasing to see in part (c) that more candidates than usual replaced the lower limit by, for example, a, carried out the integration and then considered the limiting process as $a\to 0$. However, a significant number of candidates did not specifically consider $\lim_{a\to 0} a^3 \ln a$.

Question 4

This question was answered well with most candidates able to show that they knew how to find and use a correct integrating factor to solve a first order differential equation. The majority of candidates then correctly used substitution or inspection to complete the integration. Those candidates who tried to integrate by parts often made errors or did not appreciate that two applications were required. The minority of candidates who correctly expressed $\sin 2x\,\sin x$ as the difference of two cosines generally had less difficulty in completing the integration correctly.

Question 5

A majority of candidates were able to differentiate the given function correctly to find the first and second differentials although some made the second differentiation more complicated than was needed by first expressing their answer for the first derivative in terms of $\sin 2x$ and $\cos 2x$. Candidates should be aware that the expression for the derivative of $\sec x$ is in the formulae booklet.

In part (b), most candidates displayed good knowledge of Maclaurin's theorem but only those who had made no errors in earlier differentiations could score both marks for showing the printed result. It is pleasing to report that there was an improvement in candidates explicitly reaching the stage of a constant term with higher order terms in each of the numerator and denominator before taking the limit as $x \to 0$ in the final part of the question.

Question 6

Part (a) was generally answered correctly, with most candidates showing sufficient detail in reaching the printed result. Those candidates who attempted to integrate using the method of separation of variables were generally more successful than those who attempted to use an integrating factor; a missing negative sign in the initial statement of the integrating factor involving an integral was the most common error. However, it was disappointing to see that a large number of candidates could not deal correctly with the constant of integration when simplifying to $u = \mathrm{g}(x)$. A number of candidates also then did not include a second arbitrary constant when integrating to find $y = \mathrm{f}(x)$ and so it was relatively common to see general solutions to the second order differential equation not containing two arbitrary constants.

Question 7

This final question tested polar coordinates and proved to be the most demanding question on the paper. In part (a), it was pleasing to see that the majority of candidates were able to use a correct method to find the cartesian equation. Those candidates who attempted to square both sides of the polar equation were generally less successful than those who started by multiplying both sides by r. In part (b)(i), a large number of candidates only considered the solution to $\cos\theta = 0.5$ when solving $2\sin\theta = \tan\theta$ and so failed to prove that the curves only met at the two points. Those candidates who attempted to verify that the curves intersected at the pole often substituted $\theta = 0$ rather than $r = 0$ into the two equations, but then often failed to give a final statement. In part (b)(ii), candidates generally substituted $\theta = \dfrac{\pi}{4}$ correctly into the two equations but a significant minority then did not give a full justification of whether A or B was further away from the pole. Although only the better candidates understood the relevance of part (b)(ii) in finding the required area in part (b)(iii), many candidates were able to make good progress in this part of the question. It was, however, disappointing to see some solutions that did not even use the correct formula for the area of a sector in polar coordinates. Those candidates who applied the correct formula were often able to write $\sin^2\theta$ in terms of $\cos 2\theta$ and carried out the subsequent integration correctly to find the area bounded by C_1 and the line segment OP. A significant number of candidates, however, could not find a correct method to integrate $\tan^2\theta$. The most successful method was to use the identity $\tan^2\theta = \sec^2\theta - 1$ although some other candidates found the correct area bounded by C_2 and the line segment OP by using integration by parts. Although a significant number of those candidates who obtained the correct values for the two areas went on to subtract these values to obtain the correct final answer, some others added their correct values and so failed to gain the final two marks.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results statistics page of the AQA Website. UMS conversion calculator www.aqa.org.uk/umsconversion