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Mathematics MFP3

(Specification 6360)

Further Pure 3

Report on the Examination

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General

Presentation of work was generally very good and most students completed their solution to a question at the first attempt.

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

- The particular integral, of a differential equation whose complementary function is, $e^x(Ax + B)$, cannot be of the form ae^x or axe^x .
- In questions where students are asked to show a printed result, extra care must be taken and sufficient steps must be shown in the solution.

Question 1

Numerical solutions of first order differential equations are a good source of marks for all students. Once again, this topic was the best answered on the paper. The most common error involved an incorrect evaluation of $f[3.2, y(3.2)]$. Students lost fewer marks if the correct substitution into the formula had been shown before the incorrect evaluation. A slightly higher proportion of students than last year failed to give their final answer to the required degree of accuracy.

Question 2

Almost all students were able to write down the correct expansion of e^{3x}. In part (b), the great majority of students used the 'hence' approach in which the most common error was to obtain a wrong coefficient of the x^2 term, normally $\frac{15}{8}$ but more surprisingly, $\frac{25}{2}$, in the binomial expansion. Only a small number of students used the alternative method of differentiation of $e^{3x}(1+2x)^{-1.5}$ and applying Maclaurin's theorem.

Question 3

In this less familiar question, more students failed to gain any marks than in any other question on the paper. In general, only the more able students started to look for a particular integral of the form ax^2e^x, having realised that the more 'obvious' forms were included in the given complementary function. Some other students persevered after trying the forms ae^x and then axe^x, showing that each failed before then succeeding with the form ax^2e^x but a significant minority of students instead abandoned their solutions after trying one or both of these incorrect forms.

Question 4

Explanations for why the integral was improper were slightly better than those given for the corresponding question in 2012, but there are still a number of students whose explanations are not sufficiently precise. Use of the word ‘it’ instead of, for example, ‘integrand’, when explaining what is not defined at the lower limit, 0 illustrates the imprecision. In general the method of integration by parts was applied accurately and a higher proportion of students showed the relevant limiting process than last year.

Question 5

Most of the students were able to show that tan *x* was an integrating factor, although a significant minority failed to realise that $\int \frac{\sec^2 x}{\tan x}\,dx$ gave $\ln \tan x$ directly and instead wrote the integrand in the form $\cot x + \tan x$ and after integrating correctly applied the relevant log law and eventually, after further manipulation, showed that $\tan x$ was an integrating factor. The small number of students who wrote the integrand as $2\operatorname{cosec} 2x$ were generally less convincing in reaching the printed result. Almost all students showed that they knew how to use the printed integrating factor to start to solve the first order differential equation but a minority of these students could not then find a correct method to integrate $\tan^2 x$.

Question 6

In general, most students were able to obtain the printed result for the first derivative although a small number made errors on the way or failed to show sufficient steps. Both the direct differentiation and the use of a log law before differentiation methods were seen, although the second method resulted in fewer ‘slips’. There were many good attempts seen to reach a correct expression for $\frac{d^4y}{dx^4}$ in part (a)(ii) and most students showed that they knew how to find the relevant terms in the expansion by using their derivatives. The final mark for part (b) was only available to those who had correct derivatives in part (a). It was disappointing to see some less able students not attempting part (c), which should have been an easy mark to score with the aid of the formulae booklet. In general only the most able students were able to provide a convincing solution for part (d). It was not uncommon to see the expansions from parts (b) and (c) being written as a quotient of a logarithm rather than the log law being applied before the series expansions of the logarithms were substituted.

Question 7

In part (a), the method to find the general solution of this second order differential equation was well understood by almost all students. The most common error was to incorrectly solve the auxiliary equation to obtain roots $3\pm2\mathrm{i}$ although many then presented correct follow through work to score 5 of the 6 marks. However this error also resulted in the mark for part (d) not being scored. There was a significant improvement in the use of the type of substitution required in part (b) to transform a 'complicated' differential equation into a more manageable one. Whereas in the past only the most able students have been able to deal with the second derivatives in a convincing manner, this time many more students displayed this skill convincingly and, along with their teachers, should be congratulated. In part (c), the method was generally understood but a lack of care in reaching the printed answer without any errors resulted in the loss of the accuracy mark.

Question 8

As expected, this final question proved to be the most demanding one for the students with very few presenting a full correct solution. Part (a)(i) was almost always answered correctly but part (a)(ii) proved to be more of a challenge with a significant number of non-attempts. Those students who found the length of ON, by using their answer to part (a)(i) and basic trigonometry for the right-angled triangle shown in the given diagram, generally stated the correct Cartesian equation of the line PN and gave its polar equation by using $x = r\cos\theta$ and rearranging to give the answer in the printed form. Students were much more successful in finding the area of the triangle in part (a)(iii). Although most students correctly used the lengths of the sides of triangle OPN to find the correct area it was also pleasing to see the alternative approach of integrating half the square of the expression for r in part (a)(ii) between the limits 0 and $\dfrac{\pi}{3}$. There were many correct answers for part (b)(i) although not all students gave their final answer in terms of θ. The final part of the question proved to be beyond many students although most did pick up partial credit. Deciphering what limits to use was an initial problem, with a significant number of students choosing 0 as one of the limits and then referring later to the 'bit of a' region between ON and the curve. It was also apparent that a significant number of students did not seem to appreciate the relevance of (b)(i). The most successful attempts considered the integration of $\sin^2 2\theta$ and the integration of $\dfrac{1}{4}\sin^2 2\theta\cos\theta$ separately, the first being found by use of the double angle identity to introduce $\cos 4\theta$ and the second being found by writing the integrand in a form which matched the integrand in part (b)(i) for n=2 and n=4.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website: http://www.aqa.org.uk/over/stat.html

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.

UMS conversion calculator www.aqa.org.uk/umsconversion