A-LEVEL

Mathematics

MFP3 – Further Pure3
Report on the Examination

6360
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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. Students appeared to be well prepared for the examination and they were able to tackle all that they could do without there being any apparent evidence of shortage of time.

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

- The general solution of a first order differential equation must contain exactly one arbitrary constant
- The general solution of a second order differential equation must contain exactly two arbitrary constants

Question 1

This question on the application of the improved Euler formula again proved to be a very good source of marks for most students. Almost all students obtained the correct value for k_1 and most scored the method mark for k_2. However, a small minority then failed to multiply their evaluation of $\frac{\ln 10.2}{\ln 3.8}$ by 0.4. Very few students failed to give their final answer to the required three decimal places. It is pleasing to report that a much smaller proportion of students than last year lost marks by presenting just an incorrect table of values without the supporting evidence of correct substitution into a correct formula.

Question 2

In part **(a)** most students scored full marks by correctly differentiating the given particular integral and comparing coefficients to find the correct values of the three constants in the given particular integral. Although a majority of students scored full marks in part **(b)**, there was one error which occurred more than expected and resulted in a significant loss of marks. Having obtained $m = -4$ from a correct auxiliary equation, some students stated that the complementary function was $(A + Bx)\,\mathrm{e}^{-4x}$ then added this to their particular integral from part **(a)** seemingly unaware that the general solution of a first order differential equation has just one arbitrary constant.

Question 3

This question, which tested the relationship between polar and Cartesian coordinates, was very well answered with a high proportion of students scoring full marks. Errors were usually algebraic rather than stemming from a lack of knowledge of the two conversion formulae, $r\cos\theta = x$ and $r^2 = x^2 + y^2$.

Question 4

This question, which tested the solution of a second order differential equation without the form of the particular integral being given, was a good source of marks for many students. Almost all students found the correct complementary function and the majority of these stated the correct form of the particular integral as axe^{-x}; having realised that Ae^{-x} was part of the complementary function. A high proportion of students then proceeded to obtain the correct general solution. However, applying the boundary condition $y \to 0$ as $x \to \infty$ was more problematic. As mentioned in previous reports, the examiners expect students to give special attention to certain limits that are within the specification. In this question, the limit of xe^{-x} as $x \to \infty$ needed to be treated in isolation, and this was not considered by a significant number of students.

Question 5

Most students applied integration by parts correctly to reach the correct answer for part **(a)**. In part **(b)** students were expected to show sufficient detail in their solution to justify the answer 2 for the limit. A common wrong answer was a value of 0 for the limit. In part **(c)**, '$\cot 2x$ is not defined at $x = \frac{\pi}{4}$' was the most common wrong explanation for why the integral was improper.

To evaluate the integral in part **(d)**, showing the limiting process used, students were required to write $\ln \sin 2x - \ln x$ as $\ln\left(\frac{\sin 2x}{x}\right)$ before taking the limit. A significant number of students who scored the method marks lost the accuracy mark because they stated $\lim_{a \to 0}\left[\ln\left(\frac{\sin 2a}{a}\right)\right] = 2$ instead of $\ln 2$.

Question 6

In part **(a)** a significant minority of students omitted the negative sign and gave the integrating factor as $e^{\int \frac{2x}{x^2+4}\,dx}$ which resulted in the loss of at least three of the six marks. Those who used the correct integrating factor normally went on to score all six marks but some lost the final accuracy mark because they failed to insert the constant of integration and so had a general solution of a first order differential equation with no arbitrary constants. In part **(b)**, most students correctly differentiated the given substitution but there was a significant minority of these students who then made two independent errors in 'obtaining' the printed answer. Those who attempted part **(c)** generally scored the method mark but it was again surprising to see too many general solutions of the second order differential equation with only one arbitrary constant.

Question 7

The majority of students used the chain rule and quotient rule correctly to obtain the derivatives in parts **(a)**. Some students having obtained a wrong expression for $\frac{\mathrm{d}^3y}{\mathrm{d}x^3}$ made a further independent error in applying Maclaurin's theorem to 'obtain' the printed answer in part **(b)(i)**; this was heavily penalised. A common wrong answer for part **(b)(ii)** was $-x+x^2-\frac{2}{3}x^3$, obtained by using the incorrect result $\ln(\cos x-\sin x)=-\ln(\cos x+\sin x)$. There were some excellent solutions seen for the final part of the question but in general many students did not appear to recognise the links with the previous parts. Those students who started correctly by writing $\ln\cos 2x-\ln\ \mathrm{e}^{3x-1}$ frequently did not recognise that the expansion of $\ln\cos 2x$ was the sum of the expansions in parts **(b)(i)** and **(b)(ii)** and also many did not write $\ln\ \mathrm{e}^{3x-1}$ as $3x-1$.

Question 8

This question on polar coordinates was the least well answered question. Although most students stated a correct definite integral for the area of the required region, showing that $\frac{1}{2}\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}}\left(1-\tan^2\theta\right)^2\sec^2\theta\ \mathrm{d}\theta=\frac{8}{15}$ proved to be too demanding for the majority. Students who used the general result $\int \tan^n\theta\sec^2\theta\ \mathrm{d}\theta=\frac{\tan^{n+1}\theta}{n+1}+c$ for $n=0$, 2 and 4 were the most successful. In part **(b)(i)** most students eliminated *r* and gained credit for writing a correct equation in $\tan\theta$ but a significant minority of these students could not solve the equation to find the correct coordinates of the points of intersection. The last two parts of this final question were, as expected, found to be very demanding. A significant number of students incorrectly assumed that P was a point on the curve $r=\frac{1}{2}\sec^3\theta$ and obtained the incorrect value for the length of OP. Other students gained partial credit for finding the correct length of AP but many of these, after applying the sine rule, incorrectly assumed that $\sin\alpha=\sqrt{\frac{27}{28}}$ implied $\cos\alpha=\frac{1}{\sqrt{28}}$. Only the most able students obtained $\tan\alpha=-3\sqrt{3}$ and stated that since $\tan\alpha$ is negative, α is obtuse so point A lies inside the circle.

Mark Ranges and Award of Grades

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

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