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Mathematics MPC3

(Specification 6360)

Pure Core 3

Report on the Examination

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General

There were many excellent scripts. A high proportion of the students attempted all questions and demonstrated sound understanding of almost all of the concepts examined. As the first half of the paper was quite straightforward, most students started confidently. The other questions offered more challenge. There was some poor presentation where students laid their work rather randomly in the space provided, omitted brackets in solutions and used wrong notations, eg $\sin x^2$ instead of $\sin^2 x$, etc. Some students' writing tended to be illegible. Students should be informed that proofs of given results should contain all relevant steps with correct use of notation and algebra throughout. There were some students who apparently did not recognise the difference between four significant figures and four decimal places. When rounded answers are requested, students should be encouraged to give non-rounded answers first in case they make a rounding error. Students should not use rounded partial results in their subsequent calculations to obtain a final result. Students seemed to manage their time very well with very few incomplete scripts seen.

Question 1

Part (a) was well answered by the majority of the students. Most students used $\mathrm{f}(x) = x^3 - 6x + 1$ and evaluated $\mathrm{f}(2)$ and $\mathrm{f}(3)$ correctly. There were students who then wrote "change of sign therefore a root" without clarifying where the root lies. Very few students rearranged the expression to use the alternative LHS/RHS method; and those who did so were less successful as they appeared to be unable to make a correct statement with many still just stating "change of sign therefore a root".

Part (b) was generally correctly derived with students occasionally losing the mark through the omission of " $= 0$".

Part (c) was answered very well but a minority of the students failed to round off their answer to four significant figures.

Question 2

In part (a), Simpson's rule generally was used very well. Very often the students stated the x values correctly; the y values had to be correct fractions (the most common choice), recurring decimals or decimals rounded to four significant figures. Some students did not consider $x = 0$ or used $x = 5$ which invalidated the formula. A small number of students transposed the multipliers 4 and 2 in the formula. Students should have used large brackets round the expression to help avoid the common error of only multiplying the first term by $\frac{1}{3}$.

In part (b), most students realised that the integral gave rise to a $\ln$ function and obtained $\frac{1}{2}\ln(x^2+2)$. The common errors were $2\ln(x^2+2)$ or $\ln(x^2+2)$. The use of limits and the combination of logarithms were usually done well; so many students who did not earn full marks were able to gain 3 marks. Some students left their final answer as $\frac{1}{2}\ln 9$. Those students who used the substitution $u = x^2 + 2$ were usually successful with this question but some students failed to change the limits.

Question 3

In part (a), apart from a small number of students who treated the expression as a product of terms instead of a sum and hence gained no marks, this was usually answered correctly. Where there were errors, it was usually with the first term as the students wrote e^{3x} or $3e^{x}$ instead of $3e^{3x}$.

In part (b)(i), most students applied the quotient rule correctly. However, poor notation such as $1+\cos^2 x$ instead of $(1+\cos x)^2$ or $\sin x^2$ instead of $\sin^2 x$ and sign errors caused marks to be lost. There were also examples of false cancellation leading to the correct result.
In part (b)(ii), here the students tended to do either very well or very badly, scoring 2 or 0. Those students attempting to use $y = \ln(\sin x) - \ln(1+\cos x)$ rarely made progress.

Question 4

In part (a), almost all the students gained the method mark for a relevant graph completely above the x-axis. To earn the accuracy mark, the students needed to indicate 4 on the x-axis, have a cusp there and correct curvature elsewhere. A small number of students did not gain the accuracy mark.

In part (b), the order of operations was crucial here. The great majority of the students recognised that a stretch and a translation were involved and most chose to describe them in that order. However, these students rarely gave the correct vector $\begin{bmatrix} 0.5 \\ 0 \end{bmatrix}$ for the translation and lost one mark as a result. The small proportion of the students who gave the translation first were more likely to gain full marks.

Question 5

In part (a), the full algebraic expression $\mathrm{f}(x) \geq -\frac{4}{3}$ was expected here. But the most common error was the reversal of the inequality, with $\mathrm{f}(x) \leq -\frac{4}{3}$ seen on many scripts.

In part (b)(i), most students followed through their value from part (a), although many lost the mark for incorrect notation by using $\mathrm{f}(x)$ rather than x. Some students failed to see the relationship between the answers to parts (a) and (b)(i) and wrote down inequalities such as $x \geq 0$ or $x \leq 0$.
In part (b)(ii), almost all students were able earn 2 marks by reversing the operations correctly and replacing y with x. But even the strongest students had difficulty gaining full marks by giving the answer $-\sqrt{3x+4}$. There were some students who interpreted the inverse function to mean $\frac{3}{x^2-4}$.

Part (c)(i) was answered very well. However, some students who reached the equation $3x = 2$ gave the solution as $x = \frac{3}{2}$. Other errors seen were $3x - 1 = 0$ and $3x - 1 = \mathrm{e}$.
In part (c)(ii), most students gained both marks. However, some students wrote “No” without an adequate reason; they needed to say “because it is not one to one” or “because it is many to one”. Statements about there being a modulus or a $\ln$ or an asymptote were not relevant.

Part (c)(iii) was generally answered well. A small number of students made errors in cancelling or in adding -4 and -1. Very few students attempted to find $\mathrm{fg}(x)$ rather than $\mathrm{gf}(x)$.

Part (c)(iv) was very poorly answered. Most students only earned the method mark for writing $x^2 - 5 = 1$. The students who considered $x^2 - 5 = -1$ usually gained the first accuracy mark. Very few students gave all four roots and a fully correct solution by rejecting the positive roots.

Question 6

In Part (a), most students gained the method mark by using the identity $\sec^2 x = 1 + \tan^2 x$ and many went on to earn the accuracy marks. A significant number of students lost the final accuracy mark through poor notation such as writing $\tan x^2$ instead of $\tan^2 x$. It was surprising to see some students working at this level to write $\frac{\sec^2 x}{\sec^2 x - 1}$ as $\frac{\sec^2 x}{\sec^2 x} - \frac{\sec^2 x}{1}$.

Part (b) proved difficult for most students. Many students assumed that they could factorise the quadratic equation and they were satisfied with factors that were clearly incorrect, such as $(\operatorname{cosec} x - 3)(\operatorname{cosec} x + 1)$. Some students misquoted the quadratic formula; some others muddled factors and roots. Most students showed a correct conversion from $\operatorname{cosec} x$ to $\sin x$ after obtaining their roots but those who attempted to convert their equation at the start rarely proceeded to a correct quadratic equation in $\sin x$. Some students discarded the negative root of their quadratic equation.

In part (c), the students who answered part (b) correctly usually gained both marks for this part, although some lost the accuracy mark for not writing their answers to the nearest degree. Where both marks were not earned, the majority of the students gained the method mark for equating $2\theta - 60^\circ$ to one of their solutions in part (b).

Question 7

In part (a), apart from small number of students who did not differentiate the expression as a product of two functions and obtained gradient functions such as $\frac{dy}{dx} = -8x \sin 2x$, hence gaining no marks, this question was usually answered very well. Some students failed to simplify their expression for the gradient after substitution of $\frac{\pi}{4}$, thus giving rise to some very complicated forms for the equation of the line.

In part (b), almost all the students demonstrated they could integrate by parts, with many gaining full marks. Where marks were lost it was usually due to an incorrect coefficient written in the integration of $\frac{dv}{dx} = \cos 2x$ with $v = 2\sin 2x$ being common. Some students failed to simplify their final expression and there were some cases where a non-exact decimal value was written as an answer. A small number of attempts at the volume instead of the area were seen.

Question 8

In part (a), the integration proved difficult for many students who gave wrong coefficients such as $\frac{1}{2}$, 2 or $\frac{1}{1-2}$ and incorrect expressions such as $-\frac{1}{1-2x}\mathrm{e}^{1-2x}$. The use of substitution often did not lead to a correct result, with $\frac{\mathrm{e}^u}{u}$ being common. Many students found the elimination of $\ln$ in $\mathrm{e}^{-2\ln 2}$ a challenge. Some students mistakenly thought that changing their result into a decimal number and showing that it approximated $\frac{3}{8}\mathrm{e}$ was a sufficient proof.

In part (b), most students gained the first method mark for giving $\frac{\mathrm{d}u}{\mathrm{d}x} = \sec^2 x$ and the B mark for either changing the limits or using the original limits after their integration. The replacement of $\mathrm{d}x$ with $\frac{1}{\sec^2 x}\mathrm{d}u$ was sometimes seen for the first accuracy mark. The identity $\sec^2 x = 1 + \tan^2 x$ was often seen but replacing $\sec^2 x$ in terms of u often produced $(1+u)$ rather than $(1+u^2)$. Many students thought that they could integrate an expression that was a mixture of u and $\tan x$ terms. A surprising number of able students had difficulty simplifying $\left(1+u^2\right)\sqrt{u}$ to $\left(u^{\frac{1}{2}} + u^{\frac{5}{2}}\right)$.

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