Version 1.0

General Certificate of Education (A-level)
January 2012

Mathematics MPC3

(Specification 6360)

Pure Core 3

Report on the Examination

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Set and published by the Assessment and Qualifications Alliance.

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General

The majority of candidates showed some understanding of most of the topics but, in some cases, parts of the syllabus had clearly only been covered superficially. As the first two questions were straight forward, most started confidently.

Questions involving inequalities require careful attention as to whether the inequality is strict or not. Candidates need to be alerted to the fact that, in a question of more than one part, one part is often a hint to help with a subsequent part. Any given result needs a full and complete proof to earn the marks.

The paper was accessible to the majority of the candidates with few very low marks being seen. Most candidates achieved good marks on at least the first 4 or 5 questions. The last 2 questions proved more challenging. The majority of candidates seemed to have managed their time well with few incomplete scripts seen.

Question 1

In part (a), Simpson's Rule was generally well done; a few omitted $x = 0$, thus invalidating the formula; a few reversed the 4 and 2 multipliers; and a few made calculator errors, with $(1 + 64) = 64$ and $2(4 + 16) = 20$ being the common ones.

Part (b)(i) was well answered by the majority of candidates. Many fully correct responses were seen. Most candidates used $\mathrm{f}(x) = 4x + 2x - 8$ or $\mathrm{g}(x) = 8 - 2x - 4x$ and evaluated either g or $\mathrm{f}(1.2)$ and $\mathrm{f}(1.3)$ correctly. There are still many candidates who then write "change of sign therefore a root" without clarification of where the root lies. Those candidates who used the alternative LHS/RHS method were less successful as they appeared to be unable to then make a correct statement, with many still just putting "change of sign therefore a root".

Part (b)(ii) was very well answered. The main error was with candidates who wrote answers to three significant figures, 1.24 and 1.23, rather than three decimal places. A few candidates gave answers to more than three decimal places.

Question 2

In part (a), there were many fully correct answers, but often the accuracy mark was lost for two separate sets not connected. Some candidates gave their answers as strict inequalities, and some gave their answers as x instead of $\mathrm{f}(x)$ and a few gave the range to be $21 - 1 = 20$. However many weaker candidates did not know how to tackle this part at all.

In part (b)(i), it was good to see that most got a correct expression, although a few candidates wrote $\dfrac{\frac{63}{x}+1}{4}$ as $\dfrac{252}{x}+\dfrac{1}{4}$. Some candidates made a sign error, getting -1 instead of $+1$. It was good to see that hardly anyone left their expression in terms of y or took the function to be $\dfrac{4x-1}{63}$.

Part (b)(ii) was very well answered with most candidates obtaining both marks. Those candidates who had made an error in part (b)(i) were usually able to obtain the method mark for a correct step.

Part (c)(i) was, again, mostly well done with just a few having $\frac{63}{(4x)^2} - 1$ or $\frac{63}{(4x-1)^2}$.

In part (c)(ii), very few candidates, even the most able, gained full marks. Most candidates gained the first two marks by equating to 1 and obtaining an equivalent expression to $x^2 = 16$, but most then offered the two solutions +4 and –4 and failed to state that the only possible solution was –4, thus taking no account of the domain for g.

Question 3

In part (a), almost everyone earned the mark.

Part (b) was answered very well. Most candidates who realised the numerator was related to the derivative of the denominator and hence required a ln function were successful in obtaining full marks. There were two very common errors:

- candidates losing the final accuracy by writing $\frac{1}{6}\ln\ 91 - \frac{1}{6}\ln 21 = \frac{1}{6}\ln 70$
- candidates losing 2 marks by obtaining an incorrect value of k; the most common value was 6 although $\frac{1}{2}$ and $\frac{1}{3}$ were also seen.

The major errors seen were expressions such as $\frac{2x^2 - 1}{12x^2 - 6}\ \ln(4x^3 - 6x + 1)$. Some candidates were able to recover by simplifying to the correct expression $\frac{1}{6}\ln\ (4x^3 - 6x + 1)$ before substitution of the limits; however some candidates substituted for 3 and 2 through the whole unsimplified expression and therefore gained no credit.

Question 4

A few candidates made no attempt at this question at all.

Part (a) was very well answered by the majority of candidates, with many obtaining full marks. Most candidates used the correct substitution for $\tan^2\theta$ and went on to produce the correct quadratic function. Factorisation was usually handled correctly with the common error of $\sec\theta = -2$ or 5 occasionally seen. The major error noticed was with the answers produced: 60°, 300°, 101.5° were usually correct but the fourth value was often given as 281.5° (from 101.5° + 180°), rather than the correct solution of 180° + 78.5° = 258.5° .

In part (b), although most candidates recognised the connection with part (a), not all realised what ‘hence’ implied. Many gave fully correct answers, but it was disappointing, at this level, how many candidates got the algebra wrong by dividing by 4 first and then adding 10. However, a significant number of candidates chose to start again and most were unable to handle the new expression and gained no further marks.

Question 5

Very few candidates scored full marks for this question.

Part (a) was well done with only a handful failing to recognise a stretch and most giving the correct direction and scale factor; most who were wrong in one of these were wrong in both. It was essential to use the correct term ‘translate’ for the other, so ‘shift’ did not earn marks and ‘transformation’ was inadequate. A few made an error in the vector but most were correct.

Most candidates were unsuccessful in answering part (b) of the question as their curve was either below the x-axis or continued into the second quadrant. Many placed the curve through e instead of $\mathrm{e} + 1$, and the curvature , for $x < \mathrm{e} + 1$, was often wrong.

Correct answers in part (c)(i) were sometimes spoiled by poor algebra. It was worrying to see the misunderstanding of the $\log$ function, with $\ln(x - \mathrm{e})$ expanded as $\ln x - \ln \mathrm{e}$ and incorrect subsequent work once a correct answer had been found: $\mathrm{e}^{-1} + \mathrm{e} = 0$ was a common such response.

In part (c)(ii), although the first mark for $x \geq 2\mathrm{e}$ was often earned (though $x \leq 2\mathrm{e}$ was common), the second mark was only gained by a very few candidates, as the part of the inequality concerning e was generally omitted completely.

Question 6

In part (a), it was essential to use the quotient rule, as requested — it is specifically mentioned in the specification — and to show sufficient steps in the proof of the given answer. It was surprising that quite a number of candidates were unable to go from $\dfrac{-\cos\theta}{\sin^2\theta}$ to the final expression.

In part (b), it was good to see some completely correct solutions though some used 30° and 45°, which was incorrect. A substantial number of candidates who correctly started the question lost a minus sign in their work.

Many candidates fell at the first hurdle by not replacing $\mathrm{d}x$ by an expression in θ and $\mathrm{d}\theta$. There were B marks available for a correct $\dfrac{\mathrm{d}x}{\mathrm{d}\theta}$, for $\sqrt{\operatorname{cosec}^2\theta - 1}$ converted to $\sqrt{\cot^2\theta}$ and for the limits in radians, but even these marks were often not earned. Unfortunately, many confused $\dfrac{\mathrm{d}x}{\mathrm{d}\theta}$ with $\dfrac{\mathrm{d}\theta}{\mathrm{d}x}$ and of course made no headway after that. Candidates who produced the correct numerical answer from their calculators without correct working did not gain marks.

Question 7

In part (a), most candidates scored the first two marks, but some missed out the minus sign when differentiating. The main problem was candidates’ inability to deal with $\mathrm{e}^{-\frac{1}{4}x}$, with $\dfrac{-x}{4}\mathrm{e}^{-\frac{1}{4}x}$ being the most common error. Where correct initial solutions were given, the next problem was forming a quadratic and then dealing with $\mathrm{e}^{-\frac{1}{4}x} \neq 0$. Very few candidates obtained the E mark, and many lost the m mark for not showing a viable quadratic. Another very common error was when $x = 0$ to give the coordinates as (0, 1). A significant number of candidates failed to find the y values after an otherwise-correct solution.

In part (b)(i), the concept of integration by parts seemed to have been met by the majority of candidates and most went in the right direction; those who chose $\dfrac{\mathrm{d}v}{\mathrm{d}x}$ to be x^2 could not recover any marks, and the same was true of values of v such as $v = \frac{-4}{x}e^{-\frac{1}{4}x}$, which were often seen. Those candidates who correctly obtained $v = -4e^{-\frac{1}{4}x}$ usually obtained the first 4 marks, but there were often sign errors in the final expression, with $-4x^2e^{-\frac{1}{4}x} - 32xe^{-\frac{1}{4}x} + 128e^{-\frac{1}{4}x}$ being the most common error.

Candidates who lost marks in part (b)(i) often obtained both the marks in part (b)(ii) by following through correctly with their solution. The main error with this part was using a coefficient of 3 rather than 9 after squaring the expression for y.

Mark Ranges and Award of Grades

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