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Mathematics MPC3

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Pure Core 3

Report on the Examination

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General

Candidates appeared to cope with the length of the paper and most made an attempt at all questions. Most problems occurred with trigonometry and the modulus. Candidates should be aware that "exact" does not mean an approximate numerical calculator value. The use of brackets in algebraic manipulation and in writing down functions of functions needs to be stressed: many marks were lost by the poor use of brackets. In questions requiring correct numerical values candidates must make their writing clear and also clarify negative signs. This is also true of sketches. If a specific degree of accuracy is asked for in a question this must be adhered to if full marks are to be earned. Using a slash in fractions can cause problems and should be avoided. Sometimes it is helpful to use a substitution for a function of x, **but**, far too many candidates used $x = \mathrm{f}(x)$, which only causes them (and markers) confusion.

Question 1

Part (a) This was generally correct. $\dfrac{\mathrm{e}^0}{6}$ was not good enough and neither was 0.16. Wrong answers included 1 and $\ln 6$.

Part (b) Many solutions were correct, often in an unsimplified form, but $\dfrac{1}{6x}$ and $\dfrac{6}{x}$ were common. Those who included $\mathrm{d}x$ or $+\mathrm{c}$ in their solution were penalised.

Part (c) The majority of the candidates got this fully correct, although a few failed to correct to 3 significant figures as required. Those who chose to keep exact values in terms of $\ln$ were among the most successful. A few made a slip in writing down digits from their calculator, and a few, after writing the correct expression failed to multiply by their $\dfrac{1}{3}$. The most common error in the application of Simpson's rule was to confuse "odd" with "even".

Question *2*

Part (a)(i) The majority of candidates were able to differentiate e^{2x} and apply the product rule correctly but a few made an error in one or other of these processes. Occasionally an attempt to simplify was incorrect.
Part (a)(ii) When finding the equation of the tangent (a line) it is essential to find the gradient (a constant) at the requisite point first. Most did this but it is disconcerting, at this level, to find candidates who give a non-linear equation as their answer by failing to do the first step. A few added $\mathrm{e}^2+2\mathrm{e}^2$ wrongly or lost exactness by evaluating $3\mathrm{e}^2$, and a few found the equation of the normal.

Part (b) Although the quotient rule was known by almost everyone, and almost all earned the first mark, some appalling algebra and trigonometry abounded thereafter. A few failed even to get the first mark as they put a term in the wrong place on the numerator, had $\sin x$ or $\cos x$ instead of $\sin 3x$ or $\cos 3x$ in one of their differentials or else their denominator was $1+\cos^2 3x$ instead of $(1+\cos 3x)^2$. A few failed to use the chain rule when differentiating $\sin 3x$ or $\cos 3x$. Those who missed the brackets around $(1+\cos 3x)$ in the numerator sometimes recovered but far too many falsely cancelled $\cos 3x$ at this stage. If the numerator was correctly expanded another mark was available, although $\cos 3x^2$ and $\cos 3^2 x$ instead of $\cos^2 3x$ for $(\cos 3x)^2$ was common; this was recoverable, but $\cos 9x^2$ was not. After that more incorrect cancellation was seen. Taking out a common factor of 6 was the safest route forward, as those who tried to deal with $6\cos^2 3x + 6\sin^2 3x$ often put it equal to 1 or 18 instead of 6. Even being correct to that stage did not ensure completion as, again there was false cancellation. Those who split the terms, then used $(1-\cos^2 3x)$ for $\sin^2 3x$ and factorised to $(1-\cos 3x)(1+\cos 3x)$ generally completed successfully. It was quite extraordinary how many methods with completely wrong working landed up at $\frac{6}{1+\cos 3x}$.

Question 3

Part (a) It was good to see that a much greater proportion of the candidates defined $f(x)$ first before they substituted values. As it is essential to get the correct numerical outcomes here it is well worth checking before moving on (eg quite a few carelessly rounded 0.0779 to 0.8). Those who used degrees could make no progress. Many lost the second mark by failing to state their conclusion and that α was in the required interval. Those who found the four numerical values needed to be precise in their statements to earn the accuracy mark.

Part (b) was well done.

Part (c) was well done with almost everyone giving both answers to the required accuracy, but those whose calculator was in degree mode earned zero.

Question 4

In part (a)(i), although the majority of candidates scored both marks here some rounded to the nearest degree, some truncated, some rounded 14.477 to 14.8, some only considered +4, and some erroneously added -14.5 or 14.5 to 90. A handful took cosec to be $\frac{1}{\tan}$ or $\frac{1}{\cos}$.

Part (a)(ii) There were some excellent full solutions here but also some disturbing misunderstanding of notation. Many candidates found it disconcerting to deal with the functions of $(2x + 30)$, for example $2\operatorname{cosec}^2 x - 1 + (2x + 30) = 2 - 7\operatorname{cosec}(2x + 30)$ was seen. They would have been well advised to use a substitution such as Y for $(2x + 30)$. A few missed the brackets around $(1 - \operatorname{cosec}^2 Y)$ thus getting a wrong equation and no further marks; some had this correct but failed to deal with the constants correctly and again could not progress. Sadly the incorrect substitution of $\cot Y + 1$ for $\operatorname{cosec} Y$ was also seen on several occasions. Once the correct factors were obtained a few stopped there (particularly those who unfortunately substituted x for $2x + 30$). Quite a few handled the -4 solution well but not the $\frac{1}{2}$ as they went on to assume $\sin(2x + 30)$ was $\frac{1}{2}$ and not 2.

Part (b) Most candidates recognised that the required transformations were a stretch and a translation. The majority started with the stretch and then, wrongly took the translation to be [-30,0] instead of [-15,0]. A few missed the correct term "stretch" and many failed to use the right terminology of "scale factor" $\frac{1}{2}$. A few had the direction of the stretch in the y-axis or the SF as 2 and a few had their translation in the y-direction.

Question 5

Part (a) Candidates should be advised to answer this question as "not 1 to 1". For those who chose this phrasing, it was not always clear whether they were referring to f or its inverse when they said that it was "many to one" or perhaps "one to many". There were many imprecise statements about square roots.

Part (b) This part was generally well done with only the odd algebraic error. However those who failed to swap x and y at the end were penalised, and those who did this as a first step tended to score better.

Part (c) Too often the negative sign was omitted here.

Part (d) It was good to see $\mathrm{fg}(x)$ almost always correct. Many correct approaches also gave $x = -\frac{1}{2}$ as an answer. Equating and then trying to square root both sides, or taking both terms to the same side seldom proved fruitful. A few took $(2x + 1)^2$ as $4x^2 + 1$ which was disappointing at this level, and $2x^2 + 4x + 1$ was also quite common.

Question 6

Part (a) This was well done.

Part (b) The majority recognised what was required and obtained the relevant quadratic even if their notation was sometimes a bit suspect. A few used a substitution for $\ln x$ which helped, but those who used x instead of, say Y, occasionally forgot to change back to earn the final marks. The occasional candidate changed $3\ln x$ to $\ln(x^3)$ which was not helpful, and after multiplication by $\ln x$ there were a few $(3\ln x)^2$ terms seen.

Question 7

A small number of candidates clearly did not recognise the modulus function at all.

Part (a)(i) Most graphs were in the correct place and looked linear. However a few failed to extend into the first quadrant and many were lacking the values of either one or both intercepts and a few had the vertex labelled $-\frac{1}{3}$ or -3.

Part (a)(ii) Although almost all graphs had the three requisite sections, quite a number had the outer parts linear or curving convexly instead of concavely. Many did not have all three intercepts correctly labelled.

Part (b)(i) The more able candidates were able to form two different quadratic equations and solve them, but many got only one pair of roots. However many formed wrong equations such as $3x + 3 = x^2 + 1$ as well and got extra roots. Having found correct roots some assumed that their negatives would also be roots, misunderstanding the modulus. Those who tried to square both sides usually made algebraic errors, and only a handful were able to establish correct roots from their quartic equation. Another misunderstanding about the modulus function caused some to discard the negative values that they had found.

Part (b)(ii) It was very common for the answers here to be between their values rather than outside them. Only more able students produced the correct intervals.

Question 8

Almost everyone earned the mark for differentiating $1 + 2\tan x$ correctly. It was good to see some excellent fully correct solutions, but many candidates made no further progress. Some had problems dealing with the 2, either at the substitution stage or when trying to simplify in order to integrate. Many failed to recognise that $\cos^2 x \times \sec^2 x$ equals 1. It was disconcerting to see these terms jumping from one side of the integral sign to the other on some scripts. Some tried to write these expressions in terms of u and did not progress further. A few failed to substitute back into an expression in x at the end.

Question 9

Part (a) In applying integration by parts, it was essential to start off in the correct direction and many failed at the first fence. A few fell by integrating x to x^2 and losing the $\frac{1}{2}$. It was disappointing how many candidates failed to simplify the second integral properly and integrate it to get $\frac{x^2}{4}$.

Part (b) This differentiation was generally well done, mainly using the chain rule but also the product rule.

Part (c) It should be clear from previous reports that the initial mark here requires a fully correct integral, simplified in terms of x, including $\mathrm{d}x$, with the limits and in this case also π. The function needed to be squared and this proved to be the downfall of many candidates as they needed to use correct notation. Able candidates then recognised how to split the integral, apply integration by parts and use part (b) and then part (a) [or vice versa] to complete. A significant number had a sign error in their final expression as, again, they failed to use brackets correctly.

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