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General Certificate of Education

Mathematics 6360

MPC1 Pure Core 1

Report on the Examination

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General

The question paper seemed to provide sufficient challenge for able candidates whilst at the same time allowing weaker candidates to demonstrate their understanding of differentiation, integration, rationalising the denominator of surds and completing the square. Algebraic manipulation remains a weakness and the number of arithmetic errors suggested that some candidates have become too dependent on a calculator for simple arithmetic.

When a printed answer is given, this precise form must be seen as a final equation or expression in the candidate's work. If a question asks for a particular result to be proved or verified then a concluding statement is expected. Some candidates might benefit from the following advice.

- When asked to use the Factor Theorem, candidates are expected to make a statement such as "therefore $(x + 3)$ is a factor of $\mathrm{p}(x)$" after showing that $\mathrm{p}(-3) = 0$.
- The straight line equation $y - y_1 = m(x - x_1)$ could sometimes be used with greater success than always trying to use $y = mx + c$.
- The rate of change of y with respect to t for a given value of t is given by the value of $\frac{\mathrm{d}y}{\mathrm{d}t}$.
- When solving a quadratic inequality, a sketch or a sign diagram showing when the quadratic function is positive or negative could be of great benefit.
- The only geometrical transformation tested on MPC1 is a **translation** and this particular word must be used rather than "move" or "shift" etc.
- The area of a region is a positive quantity, and a negative result from an integral may need to be interpreted accordingly.
- If a question uses the word "hence" then the previous result must be used; any other method is likely to result in no marks being scored.

Question 1

In part (a), most candidates realised the need to find the value of $\mathrm{f}(x)$ when $x = -3$. However, it was also necessary, after showing that $\mathrm{f}(-3) = 0$, to write a statement that the zero value implied that $x + 3$ was a factor. It was good to see quite a large number of candidates being aware of this but others lost a valuable mark.

In part (b), some candidates used long division effectively to find the quadratic factor and, although this was the most successful method, some were confused by the lack of an x^2 term; others used the method of comparing coefficients or found the terms of the quadratic by inspection; a number used the Factor Theorem to find another linear factor, but seldom found both of the remaining factors.

Very able candidates were able to write down the correct product of three linear factors but many more were unsuccessful when they tried to do this without any discernible method.

Question 2

In part (a)(i), although some made arithmetic errors when finding the gradient of AB, the majority of answers were correct. It was necessary to reduce fractions such as $4/2$ in order to score full marks. In part (a)(ii), those who chose to use Pythagoras' Theorem, calculating lengths of sides to prove that the triangle was right angled, scored no marks here. The word "hence" indicated that the gradient of AB needed to be used in the proof that angle ABC was a right angle. A large number of those using gradients failed to score full marks on this part of the question. It was **not** sufficient to show that the gradient of BC was $-1/2$ and then to simply say "therefore ABC is a right angle"; an explanation that the product of the gradients was equal to -1 was required.

In part (b)(i), most candidates were able to find the correct coordinates of the mid point, although a few transposed the coordinates and others subtracted, rather than added, the coordinates before halving the results.

In part (b)(ii), it was rare to see a solution with all mathematical statements correct. Too often candidates wrote things like $AB = 2^2 + 4^2 = 20 = \sqrt{20}$ and, although this was not penalised on this occasion, examiners in the future might not be quite so generous. It was surprising how many candidates did not know the distance formula. Some wrote down vectors but, unless their lengths were calculated, no marks were scored.

In part (b)(iii), many candidates found an equation of the wrong line. The line of symmetry was actually BM, although some chose an equivalent method using the gradient of a line perpendicular to AC. The most successful candidates often used an equation of the form $y - y_1 = m(x - x_1)$; far too often those using $y = mx + c$ were unable to find the correct value of c, usually because of poor arithmetic.

Question 3

In part (a), almost all candidates were able to find the first and second derivative correctly, although there was an occasional arithmetic slip and some could not cope with the fraction term.

In part (b), those who substituted $t = 2$ into $\frac{\mathrm{d}y}{\mathrm{d}t}$ did not always explain that $\frac{\mathrm{d}y}{\mathrm{d}t} = 0$ is the condition for a stationary point. Some **assumed** that a stationary point occurred when $t = 2$, went straight to the test for maximum or minimum and only scored half the marks.

It was advisable to use the second derivative test here; those who considered values of $\frac{\mathrm{d}y}{\mathrm{d}t}$ on either side of $t = 2$ usually reached an incorrect conclusion because of the proximity of another stationary point.

In part (c)(i), the concept of 'rate of change' was not understood by many who failed to realise the need to substitute $t = 1$ into $\frac{\mathrm{d}y}{\mathrm{d}t}$. Some candidates wrongly substituted $t = 1$ into the initial expression for y or into their expression for $\frac{\mathrm{d}^2y}{\mathrm{d}t^2}$ and these candidates were unable to score any marks at all on this part. Even those who used $\frac{\mathrm{d}y}{\mathrm{d}t}$ sometimes made careless arithmetic errors when adding three numbers.

In part (c)(ii), it was not enough to simply write the word "increasing": some explanation about $\frac{dy}{dt}$ being positive was also required. Some candidates erroneously found the value of the second derivative when $t = 1$ or calculated the value of y on either side of $t = 1$.

Question 4

In part (a), there were far more mistakes than had been anticipated; for example, $\sqrt{50} = 2\sqrt{5}$ and $\sqrt{18} = 2\sqrt{3}$. It was also common to see poor cancelling such as $\frac{8\sqrt{2}}{2\sqrt{2}} = 4\sqrt{2}$. Examiners had to take care that totally incorrect work leading to the correct answer was not rewarded. For instance, $\frac{\sqrt{50}+\sqrt{18}}{\sqrt{8}} = \frac{2\sqrt{25}+2\sqrt{9}}{2\sqrt{4}} = \frac{10+6}{4} = 4$ was seen on a number of occasions.

In part (b), it was pleasing to see that most candidates were familiar with the technique for rationalising the denominator in this type of problem and, although there were some who made slips when multiplying out the two brackets in the numerator, particularly when trying to calculate $2\sqrt{7}\times 2\sqrt{7}$, many obtained the correct answer in the given form and it was good to see most getting the final step correct by dividing **both** terms by 3.

Question 5

In part (a), the slightly unusual form of the initial quadratic caused problems to those who forgot to add 2 after multiplying out the brackets. The first term in the completion of the square was done successfully by most candidates, although the answer $(x-4)^2 - 3$ was seen almost as often as the correct form. It was unfortunate that an error at this stage was seldom picked up by candidates when they went on to sketch the curve.

In part (b)(i), the sketch was usually of the correct shape but many drew a parabola with the vertex in the wrong quadrant, or the y-intercept was incorrect. The question did ask for the coordinates of the minimum point and this was not always stated by candidates.

In part (b)(ii), a few candidates immediately wrote down the correct equation for the tangent, whereas many felt the need to differentiate in order to find the gradient of the curve at the vertex. Many candidates seemed unaware that the vertex was actually the minimum point and that the tangent at the vertex would be parallel to the line $y = 0$.

In part (c), the more able candidates earned full marks. The term **translation** was required and, although there seemed to be an improvement in candidates' using the correct word, it was still common to see words such as "shift" or "move" being used instead. Others thought that simply writing down a vector was enough. A very commonly stated, but incorrect, vector was $\begin{bmatrix}-4\\1\end{bmatrix}$.

Question 6

In part (a)(i), many candidates did not realise that differentiation was required in order to find the gradient of the curve, but instead erroneously used the coordinates of O and A. Some tried to rearrange the terms but usually made sign errors in doing so. In part (a)(ii), those who had the correct gradient in part (a)(i) were usually successful in finding the correct equation of the normal, though not everyone followed through to the required form, and sign errors were common. However, most obtained at least a method mark here, unless they found the equation of the tangent. The main casualties were once again those who always use the $y = mx + c$ form for the equation of a straight line.

In part (b)(i), most candidates were well drilled in integration and scored full marks, although some wrote down terms with incorrect denominators. The limits 2 and 0 were usually substituted correctly, but it was incredible how many could not evaluate $32 - 38 - 8$ without a calculator. The correct value of the integral was -14, but far too many thought that they had to change their answer to $+14$ and so lost a mark. A small number of candidates differentiated or substituted into the expression for y rather than the integrated function.

In part (b)(ii), there was still some apparent confusion about area when a region lies below the x-axis. The area of the triangle was 6 units and hence the area of the shaded region was $14 - 6 = 8$ but, not surprisingly, there were all kinds of combinations of positive and negative quantities seen here. It was worrying to see so many candidates failing to calculate the triangle area, with several finding the length of OA instead. Some able candidates found the equation of OA and the area under it by integration, but this was not the expected method.

Question 7

In part (a), most candidates found at least one of the correct coordinates for the centre C, with the most common error being at least one sign error or writing the centre as $(4, -12)$. However, the correct value for the radius was not so common, with $\sqrt{15}$ being frequently seen.

In part (b), most explanations involving a comparison of the y-coordinate of the centre and the radius of the circle earned at least one mark. In order to score the second mark, some of the better answers explained why the y-coordinate of the "highest" point of the circle was -1, but most comments were insufficient. Those who proved that the circle did not intersect the x-axis needed to state that the y-coordinate of the centre was negative in order to score full marks.

Part (c)(i) was very poorly done. Many candidates tried to use their circle equation and essentially faked the given result instead of correctly using the distance formula. Once again, if candidates are asked to "show that ..." then the full equation needs to be seen in the final line of the proof and an essential part of the working was to see a statement such as $PC^2 = 3^2 + (k + 6)^2$, leading to the printed answer.

In part (c)(ii), the word "hence" indicated that the expression for PC^2 in part (c)(i) needed to be used. Candidates needed to realise that the point P lies outside the circle when $PC > r$ and that using this result immediately leads to the given inequality. The inequality sign here caused confusion with many looking for a discriminant.

In part (c)(iii), many candidates scored only the two marks available for finding the critical values -2 and -10. No doubt some would have benefited from practising the solution of inequalities of this type by drawing a suitable sketch, or by familiarising themselves with the technique of using a sign diagram as indicated in previous mark schemes.

Mark Ranges and Award of Grades

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