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MPC1 Pure Core 1

Report on the Examination

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General

It was pleasing to see that many candidates were well prepared for this unit and on the whole presented their solutions clearly. Those who did not do quite so well might benefit from the following advice.

- If P has coordinates (x_1, y_1) and Q has coordinates (x_2, y_2) then the midpoint of PQ is $\left(\frac{1}{2}(x_1+x_2), \frac{1}{2}(y_1+y_2)\right)$.
- When asked to determine whether a curve is increasing or decreasing, it is necessary to consider the sign of $\frac{\mathrm{d}y}{\mathrm{d}x}$ at the given point.
- When rationalising $\frac{6}{\sqrt{2}}$, it is necessary to multiply numerator and denominator by $\sqrt{2}$ to give $3\sqrt{2}$.
- The centre of a circle with equation $x^2+(y-5)^2=5$ is (0, 5).
- When asked to establish a printed equation such as "$x^2-4x+4=0$", it is important to include "$= 0$".
- The vertex of a parabola is its maximum or minimum point.
- A quadratic equation has two distinct real roots when the discriminant is greater than zero ($b^2-4ac>0$).
- When solving a quadratic inequality, it is wise to use a sketch or sign diagram.
- When asked to prove a given result all relevant working must be shown; able candidates should not make assumptions.
- Wrong quadratic factors should never appear: they can be checked by multiplication.

Question 1

In part (a), apart from a few sign errors, it was pleasing to see that most candidates were able to find the correct mid-point. However, those who insisted on subtracting the coordinates before dividing by 2 would do well to learn the formula in the first bullet point above. Quite a few candidates found the mid-point of AB instead of BC, and this was generously treated as a misread.

In part (b)(i), many ignored the request to simplify the gradient, but most were successful in writing the gradient of AB as $-\frac{1}{3}$.

In part (b)(ii), almost all candidates managed to write down a correct equation for the line AB, but careless arithmetic prevented many from obtaining the required form of $x+3y=7$. Some were content to give a final answer that was not in the required form, thus losing a mark.

In part (b)(iii), some candidates immediately used $m_1 \times m_2 = -1$ to find the gradient of the parallel line and scored no marks. Many who used the formula $y = mx + c$ for the equation of the straight line through C parallel to AB made arithmetic slips and did not obtain a correct final equation.

In part (c), the most common approach, and the one expected, was to use gradients in order to prove that angle ABC was a right angle. Some simply assumed the result, stating that since the gradient of AB was $-\frac{1}{3}$ then BC had gradient 3. It was necessary to show, by considering the differences of the coordinates that BC had gradient 3. Far too many simply found the two gradients and wrote "therefore the lines BC and AB are perpendicular". Since this was a proof, it was expected that the product of the two gradients would be shown to equal -1 before a statement was made about angle ABC being a right angle. Some were successful in proving the result using Pythagoras' Theorem, but many attempts were incomplete with several candidates writing $\sqrt{40} + \sqrt{40} = \sqrt{80}$ or other inaccurate statements. Others used the cosine rule, and one or two used the scalar product of two vectors in order to prove the result. A surprising number confused "isosceles" with "right-angled" and, having found two equal sides, stated that the result was proved.

Question 2

In part (a), most candidates were able to find the correct expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$, although there were some who left $+\ 5$ in their answer or added $+C$.

In part (b), It had been expected that candidates would solve the equation $\frac{\mathrm{d}y}{\mathrm{d}x} = 0$ and obtain the equation $x^3 = 8$ and hence deduce that $x = 2$. It seemed, however, that many were unable to formulate an appropriate equation, but merely spotted the correct answer: $x = 2$. This was not penalised on this occasion, provided that the candidate stated clearly that the x-coordinate of M was equal to 2.

In part (c)(i), the expression for $\frac{\mathrm{d}^2 y}{\mathrm{d}x^2}$ was usually correct.

In part (c)(ii), although the method was left open, most candidates found the value of the second derivative when $x = 2$ and correctly concluded that M was a minimum point.

In part (c)(iii), some candidates were not aware of the need to find the value of $\frac{\mathrm{d}y}{\mathrm{d}x}$ when $x = 0$ in order to ascertain whether the curve was increasing or decreasing at that point.

Question 3

Candidates did not always approach part (a) of the question with confidence. Several wrote $5\sqrt{8} = 5\sqrt{4\times 2} = 7\sqrt{2}$ or $5 + 2\sqrt{2}$; others tried to rationalise $\frac{6}{\sqrt{2}}$ by simply multiplying the denominator by $\sqrt{2}$. Consequently, it was quite common to see only one of the two terms expressed correctly in the form $k\sqrt{2}$. It was quite strange, though, to see many obtaining an answer of $13\sqrt{2}$ from completely wrong working; clearly this was not given any credit. Some combined the two terms with a common denominator but often with an incorrect numerator.

In part (b), it was not uncommon to see the denominator and numerator multiplied by different surds and the usual errors occurred as candidates tried to multiply out brackets. A few multiplied top and bottom by the conjugate of the numerator. Nevertheless, this part of the question seemed to be answered much better than similar questions in previous years, despite the fairly difficult denominator.

Question 4

In part (a), it was only necessary to complete the square for the y-terms. As a result, there were probably fewer errors this year expressing the left-hand side of the equation of the circle as $(y-5)^2$. However, the right hand side was often written as $\sqrt{5}$, -5 or -45 instead of 5.

In part (b), quite a number who had the correct circle equation in part (a) wrote the coordinates of the centre as $(5, 0)$ or $(0, -5)$. Generous follow through marks were awarded for the radius provided the right-hand side of the equation had a positive value. The wording in the question reassured most, though, that the radius was $\sqrt{5}$.

In part (c)(i), those with poor algebraic skills, often writing $2x^2$ instead of $(2x)^2$, struggled to establish the given quadratic equation. Also, quite a few made errors in their working but miraculously wrote down the given equation on their final line. A surprising number derived an equation in y. Quite a few simply solved the given quadratic equation in this part and thus failed to show an understanding of what was required.

In part (c)(ii), it was necessary to state that the equation had a repeated root of $x = 2$, or to use the zero value of the discriminant to show that the equation had equal roots, and hence to conclude that the line was a tangent to the circle.

In part (d), far too many simply substituted the coordinates of the point Q into the equation of the circle obtaining a nonsensical statement such as "$-3 = 0$ so the point lies inside the circle". It was necessary to see that the distance CQ was being calculated and then concluded that this distance was less than the radius of the circle, and hence the point Q must lie inside the circle.

Question 5

Candidates did not seem confident working with a quadratic expression where the coefficient of x^2 was negative. Throughout this question, candidates chose instead to work with the expression $x^2 + 8x - 9$, or the equation $x^2 + 8x - 9 = 0$, and lost quite a lot of marks.

In part (a), a large number of candidates could not factorise the given quadratic correctly, a few clearly not even recognising what was required.

In part (b), those who kept brackets in their working were usually successful in proving the identity. Some able candidates started with $9 - 8x - x^2$ and showed their skill in completing the square.

In part (c), quite a large number of candidates seemed unfamiliar with the terms "line of symmetry" and "vertex" and certainly failed to see the link with part (b) of the question. Some stated that the coordinates of the maximum point were $(-4, 25)$ and then wrote the coordinates of the vertex as something entirely different.

The sketches were somewhat varied: some found the wrong x-intercepts and drew a curve through these points; those who had completely changed the question into $y = x^2 + 8x - 9$ had a U-shaped graph. Those who drew a graph with the vertex in the correct position and with the correct shape usually had the y-intercept marked correctly as 9. However some drew their curve with a maximum point on the y-axis.

Question 6

In part (a)(i), a few candidates ignored the request to use the factor theorem and scored no marks for using long division. It was necessary to make a statement that " $x + 1$ is a factor", after showing that $f(-1) = 0$, in order to score full marks.

Part (a)(ii) was not answered as well as similar questions in previous years. Perhaps the sketch lured some into trying to write down three factors without any further working, rather than using the intermediate step of showing that $p(x) = (x+1)(x^2 - x - 6)$ before writing $p(x)$ as a product of three factors. Many who tried long division were flummoxed by there being no x^2 term.

In part (b)(i), those who had the correct linear factors in part (a)(ii) usually wrote down correctly that A had coordinates $(-2, 0)$, although some carelessly wrote the point as $(0,-2)$.

Many candidates simply found an indefinite integral in part (b)(ii) and then a definite integral in part (b)(iii). The two parts were generously treated holistically when candidates did this. The fractions once again caused problems to most candidates who are so used to having a calculator to do this work for them. It was very rare to see the correct answer of -32 for the definite integral.

In part (b)(iii), many lost out on an easy mark because they rolled their two sections into one: those who wrote "integral $= -32 = 32$" gained full credit for part (b)(ii) but did not score the mark in part (b)(iii). It was necessary to give a positive value for the area of the region and to make this explicit. In anticipation of a lot of wrong answers in part (b)(ii), a follow through mark was awarded in part (b)(iii): for example, if a candidate's answer in part (b)(ii) was -20 and they concluded that the area was 20 in part (b)(iii), they scored the mark.

In part (b)(iv), most candidates differentiated correctly, but quite a few thought that $3(-1)^2 - 7$ was equal to -10 and thus obtained the wrong gradient of the curve.

In part (b)(v), a large number of candidates found the correct equation of the normal but some still confused tangents and normals and consequently thought that the gradient of the normal was equal to -4. It was quite common for weaker candidates to either negate their gradient or take the reciprocal but to fail to do both.

Question 7

In part (a), some weaker candidates did not realise how to derive the given equation, and others made algebraic slips when proving the printed result, or failed to write "$= 0$".

In part (b), the condition for two distinct points of intersection required candidates to use the condition that $b^2 - 4ac > 0$ at any early stage of their argument. Those who simply wrote "> 0" on their final line of working, without any previous reference to the discriminant being positive, failed to convince the examiners that they deserved full marks.

In part (c), quite a number were unable to factorise the quadratic correctly and many resorted to using the quadratic equation formula to find the critical values. Where this was done correctly but left in surd form, it was given due credit except for the final mark. Very able candidates can write down the answer to the inequality once they have factorised the quadratic but far too many guessed at answers and an approach using a sign diagram or sketch is recommended. Candidates also need to realise that the final form of the answer cannot be written as $\frac{14}{9} < k < -2$.

Mark Ranges and Award of Grades

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