AQA

A-level
Mathematics

MPC1- Pure Core 1
Report on the Examination

6360
June 2015

Version: 1.0

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General

Once again, the question paper seemed to provide a suitable challenge for able candidates, whilst at the same time allowing weaker students to demonstrate their understanding of differentiation, integration, factorising polynomials and rationalising the denominator of surds.
When an answer is requested in a particular form, such as the equation of a straight line, students will not score full marks if their final answer is not in that specific form. Careful attention needs to be given to proofs when a printed answer is given, where once again the final line of a candidate's working should match the printed answer.

Algebraic manipulation continues to be a weakness; this was very evident when solving simultaneous equations, multiplying out brackets and factorising quadratic expressions. The number of arithmetic errors suggested that some students have become over-dependent on a calculator for simple arithmetic.

Weaker students might benefit from learning accurately a few basic formulae such as the general equation of a circle and the quadratic equation formula so as to avoid losing precious marks. Future students might appreciate the following advice:

- 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 quadratic equation formula needs to be learnt accurately and values substituted correctly or no marks will be earned
- 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 line of symmetry of the curve $y = (x + p)^2 + q$ has equation $x = -p$
- The vertex of the curve $y = (x + p)^2 + q$ is $(-p, q)$
- A concluding statement is expected whenever a question asks for a particular result to be proved or verified
- When asked to use the Factor Theorem, students are expected to make a statement such as 'therefore $(x + 2)$ is a factor of $p(x)$' after showing that $p(-2) = 0$
- The circle with equation $(x - a)^2 + (y - b)^2 = k$ has centre (a, b) and radius $\sqrt{k}$

Question 1

(a) Most candidates were able to find the correct gradient, although some insisted on writing the gradient as $-\frac{3}{5}x$. Because both coefficients in the equation $3x + 5y = 7$ were positive, there was possibly a higher success rate in finding the correct gradient than in previous years; a few confused the gradient with the y-intercept and gave their answer as $\frac{7}{5}$.

(b) The most successful attempts at the equation of the line used an equation of the form $y - y_1 = m(x - x_1)$, as flagged above. Many who tried to use $y = mx + c$ lost marks because they made arithmetic errors when trying to find the value of c. Some candidates did not appreciate the need to find the negative reciprocal of their gradient from part **(a)**, clearly confusing the conditions for perpendicular and parallel lines.
Although most students found a correct equation, many mistakes were seen when trying to rearrange their equation into the required form with integer coefficients.

(c) Most candidates made an attempt at the simultaneous equations, and many obtained the correct solution. Poor algebraic skills and carelessness were often evident here; elimination of one of the variables proved to be the most successful approach; those using substitution were usually unable to cope with the fractions and negative signs. It was encouraging to see most candidates able to simplify fractions such as $-\frac{76}{19}$ without a calculator. Some candidates did not read the question carefully, and no credit was given to those who used the wrong pair of equations.

Question 2

This was a high scoring question with many candidates scoring full marks. Rationalising the denominator continues to be a skill that is well practised. Most of the wrong answers came from the fundamental error of writing down an incorrect expression for the gradient. The most common arithmetic error arose from simplifying the numerator; $14 - 2\sqrt{15}$ was seen far too often and others found difficulty simplifying $20 - 6$. Because of the printed answer very few errors were seen this year when going from the penultimate line with the correct numerator and denominator to the final line.

Question 3

(a) A large number of candidates found the equation of the line AB instead of the equation of the tangent to the curve at A. Apart from that, it was good to see candidates able to differentiate correctly and most were then able to obtain the correct gradient of the tangent. In this part, because candidates could give any correct form of the equation, many scored full marks for writing down $y - 6 = -10(x + 1)$; many of those who tried to use $y = -10x + c$ made mistakes when trying to find the value of c.

(b)(i) Integration of polynomials is well drilled. There were few errors seen but the most common involved the constant term; some kept the term as 2 and others omitted the final term, possibly confusing differentiation with integration. It was sometimes difficult to follow some candidates' work when they substituted the limits separately and then tried to combine the two results. When this was done there were often sign errors and it was difficult to know whether an addition or subtraction had been attempted. The fractions were possibly easier to handle this year but it was encouraging to see fewer arithmetic errors when combining fractions.

(ii) A considerable number of candidates presented the value of the definite integral as their final answer to the area of the shaded region instead of considering the difference of the area of the appropriate trapezium and the value of the integral. Some insisted on using a definite integral to find the area of the trapezium when it seemed so much easier to consider a triangle and a rectangle or to use the formula for the area of a trapezium.

Question 4

(a) Some weaker students did not seem familiar with the standard equation of a circle, with several writing the left hand side of the equation as $(x+2)^2+(y-6)^2$. Sign errors were common with the first term often being written as $(x-1)^2$. However, most errors were associated with the value of d where typical incorrect values seen on the right hand side of the equation were 40, 49 and $\sqrt{50}$.

(b)(i) Most candidates earned a single mark here since it was earned as a follow through from their circle equation.

(ii) Credit was given for taking the square root of their value of d, but candidates had to have the correct surd expression to be awarded both marks.

(c) This part was also answered very well. Occasionally candidates only offered the single value $k=8$, usually as a result of using the equation $(k-3)^2=25$ rather than the more common quadratic equation $k^2-6k-16=0$.

(d) A number of candidates made no attempt at this part and some drew a diagram indicating the wrong hypotenuse. Most candidates used Pythagoras correctly and found the correct value of the shortest distance from the centre of the circle to the chord.

Question 5

(a) The coefficient of x, being an odd number, caused problems in previous years for a large number of candidates when completing the square but there was a marked improvement in those completing the square correctly; nevertheless quite a few were still unable to square 1.5 without a calculator.

(b)(i) A few made sign errors in at least one of the coordinates but the idea of finding the vertex of a quadratic curve seemed to be well understood.

(ii) The equation of the line of symmetry was not usually stated correctly, with several writing down the equation of a curve rather than a straight line; the incorrect equation $y=-\frac{3}{2}$ was seen far too often, whereas others simply wrote down numbers such as $-\frac{3}{2}$ or $-\frac{1}{4}$.

(c) Since this was the first time a question like this had been set, it was pleasing to see the variety of successful approaches to finding the new equation. Some replaced x in their equation by $x-2$ and y by $y-4$ but poor algebraic skills caused many to obtain the wrong final equation. Others realised that the new vertex was $(0.5, 3.75)$ and immediately wrote down the new equation as $y=(x-0.5)^2+3.75$, but once again errors often arose in changing the equation to the required form.

Question 6

(a)(i) Many candidates seemed to have forgotten the formula for the curved surface area of a cylinder and confused it with the formula for its volume. Despite the emboldened word **open**, a considerable number of candidates used $2\pi r^2 + 2\pi rh$ as the formula for the area of the curved surface and base. Many equated their expression to 48 and so it was rare to see a correct expression for h in terms of r.

(ii) There was a great deal of working back from the printed answer and so examiners had to be alert to identify what was a genuine attempt to use $V = \pi r^2 h$ correctly. Credit was given for substituting the candidate's expression for h from part **(a)(i)** into this formula for V, but there was so much crossing out and fudging of results that very few solutions were seen that deserved full marks.

(b)(i) Most candidates only started to earn marks at this point. Many attempts at differentiation had the π missing from at least one of the terms but most candidates were able to find the correct expression for $\frac{\mathrm{d}V}{\mathrm{d}r}$.

(ii) Even those who had the correct derivative in part **(b)(i)** struggled to solve the resulting equation in r, often finding the π difficult to cope with. Many who did obtain the value $r = 4$ when V was stationary often spoiled their solution by omitting the minus sign when finding $\frac{\mathrm{d}^2V}{\mathrm{d}r^2}$.

Others were penalised for using expressions such as $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ instead of $\frac{\mathrm{d}^2V}{\mathrm{d}r^2}$.

Question 7

(a) This was perhaps the worst answered section of the entire paper. The question was meant to test the awareness of the double root and hence a stationary point when $x = 0$, but many candidates sketched a graph through the origin with a maximum or minimum point when $x = 3$; others drew a quadratic curve and also scored no marks.

(b)(i) Some used long division or similar methods such as synthetic division and these candidates were rarely successful in finding the correct remainder. The best attempts involved the use of the remainder theorem and it is strange that so many candidates avoided this straightforward method.

(ii) Those candidates who chose to use long division or other division techniques, perhaps misunderstanding what was meant by 'The Factor Theorem', scored no marks. It was good that most realised the need to find the value of $\mathrm{p}(x)$ when $x = -2$. However, after showing that $\mathrm{p}(-2) = 0$, it was also necessary to write a concluding statement regarding $x + 2$ being a factor; a few evaluated $\mathrm{p}(2)$ and scored no marks.

(iii) Those who found the quadratic factor using inspection were the most successful; methods involving long division or equating coefficients usually contained algebraic errors.

(iv) Credit was given for finding the discriminant of the quadratic obtained in part **(b)(iii).** Candidates needed to explain that the discriminant was negative and hence that the quadratic had no real roots before stating that $x = -2$ was the only real root. Some hedged their bets by presenting both the factor $x + 2$ and the root and lost the final mark.

Question 8

(a) The few lines in this proof needed to have no errors in order to score this mark. The use of trailing equals signs and poor use of brackets sometimes robbed students of this mark.

(b)(i) Most candidates who attempted this part realised the need to use the discriminant ($b^2 - 4ac$) and almost all expressions this year involved k. The main error came from using $c = 13$ instead of $13 - k$. The condition for no real roots seemed widely understood and most solutions introduced the condition $b^2 - 4ac < 0$ before the final line of their working. Careless algebra still spoiled a few good attempts.

(ii) It was encouraging to see far more attempting to factorise the quadratic than in previous years when far too many resorted to using the formula and then could not handle the large numbers without a calculator. Most candidates found the correct critical values but then many made no attempt to solve the inequality. Those who used a sign diagram or a sketch graph usually fared better when solving the inequality.

Mark Ranges and Award of Grades

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UMS conversion calculator