Examiners' Report

Principal Examiner Feedback

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Pearson Edexcel International A Level

In Pure Mathematics (WMA11/01)

Paper: WMA11/01

General

This paper did not prove too challenging and almost all students were able to make a reasonable attempt at most questions although it was disappointing to see a significant number of candidates who made no attempt at some questions. Questions 3, 4, 9 and 10 caused the most difficulty, perhaps as these required a problem-solving approach, rather than using standard, learned methods. As in previous papers marks were lost by students who used calculators on questions where this was not permitted, but also it was noticeable that calculators were not always used when they were allowed. On the whole candidates showed sufficient working, but some did not understand the need for a complete method to be clearly shown in questions 7 and 9, where the required answer or expression was given in the question

Report on individual questions

Question 1

This was an accessible opening question which almost all candidates attempted. The majority made a correct attempt at integration, gaining at least the first 2 marks for $3x^4$, with only a very few differentiating instead of integrating. The most common errors were sign slips on the $\frac{1}{2}x^{-3}$ term and missing the constant $+ c$. A few students wrote the integral sign at the start of every line and so lost the final mark for incorrect notation.

Question 2

This question gave almost all candidates the opportunity to score some marks though many candidates failed to achieve full marks.

The vast majority of candidates were able to differentiate the given expression for y correctly and set their derivative equal to 2 gaining the first two marks. Most candidates collected terms to form a three-term quadratic equation and a significant number of these candidates chose to replace x^2 with another variable before factorising. The higher powers caused problems for some candidates who did not see a way of solving the quartic. The final two marks were rarely achieved as many candidates failed to show that they had divided through by 3; we require the factorised form to match the quadratic: $15x^4 + 12x^2 - 3$ does not factorise to $(5x^2 - 1)(x^2 + 1)$. A small number of candidates chose to replace x^2 by x and were rarely successful in finding the correct solutions. A small number of candidates went on to find the corresponding values of y, which was not required.

Question 3

This inequality question, requiring the use of algebraic and graphical techniques, was not well answered and it was rare for a student to gain full marks.

Part (i) was missed out altogether by a significant number of candidates who either felt unable to attempt it, or did not see it and went straight to part (ii). By far the most common answer given was $x < 3/4$, found by rearranging the inequality, which gained just one mark. The few students who used the method of multiplying by x^2 usually achieved the correct inequality. Some attempted to consider $x < 0$ and $x > 0$ separately, with varying degrees of success. It was rare to see a sketch graph, which would have helped students to see that $x > 0$ was required.

Again, in part (ii) many students had little idea of how to approach the question. Some wrote $y = 3x$, but did not continue to find $y = 3x + 15$, using the intersection of $y = 3x + c$ with curve C on the x-axis. Others lost marks for using incorrect or inconsistent inequality signs. It was common to see candidates scoring the first 2 marks, usually for finding inequalities relating to the quadratic and linear equations, but far fewer achieved the final mark for the inequality in x.

Question 4

This question gave almost all candidates the opportunity to score some marks though many candidates failed to achieve full marks in either part. Candidates who wrote their answers in the script of the question were not penalised.

Part (a i)

Candidates were split between the correct solution of (90, –1) and (180, –2) which presumably came from mistakenly thinking that the transformation mapping cos(x) to cos($2x$) is a stretch in the y-axis direction. There were many candidates who correctly identified this as a stretch on the x-axis and of scale factor ½. Occasionally, answers were given in radians, which was penalised. A small number of candidates were confused as to how to present coordinates giving (–1, 90) for example.

Part (a ii)

The vast majority of candidates who achieved the coordinates of Q correctly, went on to achieve the correct value for k. A small number of candidates interpreted the graph as showing exactly 1 period, instead of 1¼. A small number of candidates gave the value of k as a coordinate, which was not penalised.

Part (b)

Candidates tended to score either full marks or zero with only a few candidates getting one of the correct options for p. Some candidates thought that p referred to values along the x-axis; for example, $45 < p < 135$. A significant number of candidates mistakenly gave $0 < p < -1$ as a solution. Answers were required to be in terms of p and answers given in terms of y were penalised, whilst the use of any other variables scored zero. An incorrect Q in part (a i) was followed through for the method mark. A large number of candidates did not attempt this part of the question.

Question 5

This question was generally attempted well, with many candidates gaining full marks.
In part (a) it was rare not to see the first 3 marks awarded for correctly finding the equation of the normal, with only a small number of the cohort making errors in rearranging the given equation or in stating the gradient of the perpendicular. Most students then went on to use a correct method to find the intersection point *P*. Surprisingly almost all used an algebraic method to solve the simultaneous equations, rather than using a calculator, even though this was not a non-calculator question. Arithmetic errors were the most common reason for incorrect coordinates for *P*. However, a few students made both equations equal to 0 and then put them equal to each other, resulting in an equation with two unknowns, followed by incorrect coordinates.

A small number of students did not attempt part (b), even if they had full marks in part (a). The majority found the *x*-coordinate of *B* correctly, with the most common incorrect answer being *B*(0, 10). Most then used a correct method to find the area of the triangle, with candidates who found incorrect coordinates in (a) still able to gain the first two marks in (b). The most common correct method used was ½ x (24 + 15) x 18, with the most frequent error being to use the *x*-coordinate 12 as the height of the triangle. It was less common to see sides *AP* and *BP* used as the base and height of the triangle, but many students using this method achieved the correct answer. A few used trigonometry to find one of the acute angles in the triangle and then used ½ *ab* sin *C* method, sometimes correctly, but they often did not manage to achieve the exact answer required. The shoelace method was rarely used and was generally the least successful.

Question 6

This question gave almost all candidates the opportunity to score some marks. Many candidates were able to achieve full marks.

Part (a)

The vast majority of candidates were able to produce a positive cubic shaped graph, although a few candidates were inclined to feature a cusp at the minimum point on the x-axis. If the scheme had been more stringent concerning the extreme ends of the sketch, some candidates would have lost the first two marks due to questionable curvature as x tended to plus or minus infinity. A high proportion of candidates had the x-axis intersection at $(-1, 0)$ and the minimum at $(3, 0)$ correctly located and labelled, but a surprising number of candidates failed to label the y intercept at $(0, 18)$. A small number of the candidates used calculus to find the coordinates of the maximum, which demonstrated knowledge beyond the scheme for this paper and was not required. Those candidates who failed to sketch a positive cubic shape mostly produced a quadratic and were still able to score the mark for a correct y-axis intercept.

Part (b)

This was where virtually all candidates were able to score at least one mark and most were able to achieve the correct cubic by multiplying out the given expression for $f(x)$. Those who lost marks tended to be careless with either the application of brackets, in particular with $2(x + 1)$ being taken as $(2x + 1)$, or $(x - 3)^2$ being taken as $(x - 3^2)$ or with slips in simplifying terms.

Part (c)

The process of using differentiation to find the equation of a tangent is a standard technique and many candidates proceeded to write down $f'(x)$ and went on to evaluate $f'(\frac{1}{3})$. Of the large number of candidates who got as far as $f'(\frac{1}{3}) = 0$ quite a number were thrown by the zero gradient and therefore did not score the final mark for the equation of the tangent. A significant number of candidates who had reached this stage proceeded to find the equation of the line using $y - {}^{512}/_{27} = 0(x - \frac{1}{3})$
A small number of candidates failed to reach zero due to arithmetical slips. Candidates who began this part by working out the value of $f(\frac{1}{3})$ and proceeded no further, were not given credit for finding the equation of the line; losing all four marks in this part.

Question 7

This question, requiring the use of the sine and cosine rules and formulae for arc length and sector area was attempted by almost all candidates. A significant minority were not comfortable using radians and converted to degrees and back again unnecessarily.

In part (a) those students who used the cosine rule to find *OB* and then the sine rule to find half of angle *OAC* were generally successful, though a few lost the final mark because of lack of accuracy or not showing full working. Some achieved a correct result by using the cosine rule twice. It was not unusual to see a circular method, where the given answer was substituted and then found again, gaining no marks. A significant number of candidates did not make a full attempt at part (a) but were generally able to gain marks in the rest of the question.

Part (b) was answered correctly by most candidates, with only a few using an incorrect formula for the arc length or adding on the radii. The most common mistake was to use 1.64 as the angle, finding the minor, rather than the major, arc length.

In part (c) almost all candidates used $\frac{1}{2} r^2 \theta$ correctly to find the sector area or found the area of the circle and subtracted the area of the minor sector. Again, some of the cohort used 1.64 as the angle for the major sector. Finding the area of the kite proved more challenging. Those who used $\frac{1}{2} ab \sin C$ to find the area of triangle *OBC* and then doubled it were by far the most successful. Other common methods attempted were to find and add the areas of triangles *OAC* and *ABC* or to find the area of the rhombus as half the product of *OB* and *AC*. These were used successfully by some students, but often calculations were incomplete or errors led to an incorrect final answer. Very rarely students attempted to subtract the area of the segment from the area of the circle and then added the area of triangle *ABC*. This involved more calculations and a fully correct solution using this method was rare.

Question 8

This question gave almost all candidates the opportunity to score some marks. Many candidates were able to achieve full marks. The work of some candidates suggested an inability to distinguish between the two keywords "equation" and "expression". There were a significant number of slips with the manipulation of negative numbers.

Part (a i)

The vast majority of candidates realised that b needed to be ± 3 but many struggled with the signs.

A good technique when completing the square with a negative x^2 term is to take out a factor of -1 at the start of manipulating the expression $-(3x^2 - 12x - 4)$. A significant number of candidates simply changed the signs of each term as if they were dealing with an equation. A few candidates felt the need to end this part of the question with an equation by writing their expression equal to zero; some even tried to solve this quadratic equation. A very small number of candidates reached the correct expression $16 - 3(2 - x)^2$ but this lost the final mark as it is not yet in the required form with a positive x term in the bracket. A very small number of candidates used the approach of comparing coefficients but this was usually not a successful method.

Part (a ii)

A large number of candidates directly stated the coordinates of M from the completed square form in part (a i) and in the vast majority of cases were able to get both marks following through their work. A small number of candidates were unsuccessful in using the completed square form of $a + b(x + c)^2$ to state the coordinates of the maximum point giving various combinations of $(\pm c, \pm a)$. A significant number of candidates ignored part (a i) and found the coordinates of the maximum point, M, by differentiating the equation of curve C and setting their $\frac{dy}{dx}$ to zero. These candidates were generally successful.

Part (b)

Candidates were split evenly on the approach taken in this part of the question with both approaches being very successful.

Roughly half of the candidates who attempted this part stated that the equation of the second line must have the form $y = 8x + k$ and substituted this into the equation of the curve to form a quadratic equation. By setting the discriminant of this equation to zero, they were able to find the value of k.

The majority of candidates who took this approach were successful with others making slips with signs or in stating the discriminant could be greater than or equal to zero. The other half of the candidates differentiated the equation for the curve, set this equal to 8 and solved the quadratic equation formed, this enabled them to find the coordinates of the point of contact and by substituting into an equation of a straight line along with their gradient of 8, to find k. Almost all candidates who took this approach were successful. It was rare for a candidate to attempt to use the completed square form from part (a i) in this part of the question and due to errors with signs they were usually unsuccessful.

Question 9

This was a challenging question for most students which proved to be a good discriminator, with only the most able students gaining full marks. It required knowledge and understanding of transformation of graphs, composite functions and surd manipulation. Few gained full marks and a significant number made no attempt.

In part (a) it was very common to see the graph of $y = f(x) + 3$ starting at the origin and the graph of $y = f(2x)$ below the graph of $y = f(x)$, or on top of it. Unfortunately, quite a number of candidates gained no marks as they did not label either of their graphs. Others drew their two graphs on separate diagrams, despite instructions to draw both graphs on Diagram 1, which often made it impossible to judge whether a graph was in the correct position in relation to $y = f(x)$. Most students who indicated the points to which P was transformed marked (9, 6) correctly, but fewer correctly labelled (4.5, 3) on $y = f(2x)$

Part (b) was not well answered and many candidates missed it out altogether. Of those who attempted it, the majority gained the first mark for writing $\sqrt{2x} = \sqrt{x} + 3$ but many were not able to collect $\sqrt{x}$ outside a bracket in order to progress. Of those who did, it was common to see $\sqrt{x} = \frac{3}{\sqrt{2}-1}$ and then the given answer with no rationalisation shown, losing the final mark. Some candidates squared both sides of the correct equation and reached a quadratic in $\sqrt{x}$. A few used this method successfully but most did not realise that they needed to use the quadratic formula, and so they gained no marks. Common mistakes were using $f(2x) = 2\sqrt{x}$ or $\frac{\sqrt{x}}{2}$ or $\sqrt{\frac{x}{2}}$, which rarely led to them gaining credit, since their working was usually very much simplified.

In part (c), those candidates who realised that they needed to square the given answer in (b) were generally successful in finding x, even if they did not complete part (b). A common error was to see $\sqrt{2}+1$ squared to give $2 + 1$. Many students did not realise that to find y they just need to add 3 to the given answer for $\sqrt{x}$. Decimal answers were common for y, as were $3\sqrt{2}+3$ and $\sqrt{(18\sqrt{2}+27)} + 3$ which all lost the final mark.

Question 10

This question caused candidates difficulty possibly due to the quantity of information given at the start. There was a significant number of candidates who did not attempt this final question. The scheme generously allowed parts (a) and (b) to be "marked together" which meant that candidates who simply integrated at the start were credited for this.

Part (a)

The vast majority of candidates differentiated the given f'(x) and set their f''(27) equal to zero to find a. There were few arithmetical or sign errors but the most common was to reach 0 = a – $4(27^{-2/3})$ and then to mistakenly give $a = -4/9$. Throughout this question a small number of candidates applied given information incorrectly and in this case, they either set f'(27) = 0 or used the point (1, –8) in their f''(x).

Part (b)

The vast majority of candidates integrated the given f'(x) to obtain f(x) and found c by substituting the point (1, –8). Many candidates achieved full marks. There were slips such as using the point (1, 8) or even (–8, 1). A small number of candidates forgot to include the constant of integration and so had no access to the final 3 marks. Some candidates who were dubious as to the accuracy of their value for a, or who had not yet attempted part (a) chose to work in terms of a and this was not penalised for the first 2 marks.