Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level
In Pure Mathematics P1 (WMA11) Paper 01

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General

This paper proved to be a good test of candidates' ability on the WMA11 content and plenty of opportunity was provided for them to demonstrate what they had learnt. Marks were available to candidates of all abilities. The questions that proved to be the most challenging were 4, 5, 9 and 11.

Presentation was generally good and candidates often showed sufficient working to make their methods clear. In some cases candidates did not show sufficient working to justify their answer such as in question 1(b) where there was a requirement for candidates to show how to get from $\frac{5}{\sqrt{2}} - 3\sqrt{2}$ to $-\frac{\sqrt{2}}{2}$ or $-\frac{1}{\sqrt{2}}$ in order to access the final mark. A calculator warning was provided in this question as a pointer to this. It is worth stressing here the importance of adhering to the calculator warnings given in the paper. For example in question 3, candidates were told that solutions relying on calculator technology were not acceptable. This impacted on part (b) where some candidates failed to show a method for solving the quadratic equation from part (a) and simply wrote the roots down from a calculator.

Some candidates did not appreciate the rigour required in the proof in question 2 part (a) in that, having completed the correct work, failed to give a suitable explanation and/or conclusion.

Report on Individual Questions

Question 1

Overall, this question seems to have been accessible to the majority, with very few being unable to achieve some credit.

Part (a) was completed correctly by a good number of candidates, competently dealing with negative and fractional indices when differentiating. Most candidates were able to achieve at least one correct term, and very few retained the 2. There were a few cases where candidates integrated rather than differentiated, and a significant number of candidates who differentiated but then added + c to their expression.

Part (b) proved more challenging for a number of candidates, although most were able to achieve the mark for substituting into their expression from part (a) provided it wasn't the given function. A significant number of candidates ignored the request to give an exact value for the gradient, resorting immediately to a decimal answer, while others seemed unable to manipulate the indices to surds and then achieve an answer in the required form showing sufficient working in the process.

A significant minority of candidates who had introduced "+ c" in part (a) went on to try and establish its value by for example using $x = 2$ and $y = 0$.

Question 2

Many candidates made a good attempt at part (a). The two most common approaches were to work with gradients multiplying to give –1 or to calculate lengths and work with Pythagoras or the cosine rule.

The calculation of the appropriate gradients was generally successful, with the product of correct gradients shown to give –1. However, a small number of candidates simply left it at that without any reference to the fact that it indicated the two lines were perpendicular or that the angle was a right angle.

When using lengths, the Pythagoras/cosine rule process was more problematic with a significant number not achieving the correct lengths. Some were confused and used incorrect coordinates or formulae for the lengths of lines. Some did not use the difference of the coordinates squared but the difference of the squares of the coordinates e.g. $11^2 - 7^2$. A small number of candidates lost the final mark by using decimal values for the lengths instead of the exact values.

Candidates sometimes omitted the conclusion step, losing the final accuracy mark. This was particularly prevalent when attempting to prove via Pythagoras when they did not provide enough explanation to accompany the method. Candidates who used the cosine rule, generally fared better as a solution to the equation was required e.g. $\theta = 90°$, rather than a concluding statement to a proof. A few candidates worked out the equations of the lines through *PQ* and *QR*. A very small number of candidates attempted to use vectors in this part.

Responses to part (b) were mixed, with many candidates scoring no marks and others scoring full marks. Candidates who worked by counting units between points or used vector methods were most confident in reaching the correct, or partially correct, answer. Candidates who attempted to find equations for *RS* and *PS* and solving simultaneously rarely produced enough work to score full marks. While they managed to find correct equations, they often gave up before solving simultaneously, or made algebraic errors that prevented the accuracy mark being awarded. A few candidates attempted to work with the length of the line and form simultaneous quadratic equations. However, they did not complete enough of the method to warrant the method mark. A more unusual but often successful approach was to use the mid-point of the rectangle. The majority that did obtain the correct answer simply stated the coordinates with no calculation.

Question 3

There were many fully correct solutions to this question, however, some candidates had no idea how to write the expression as the sum of two terms. A small minority attempted to integrate all 3 terms separately before division which resulted in no marks. Of those candidates who realised they needed to write the expression as two separate terms, some had difficulty with the initial division and ended up with incorrect expressions such as $8x^3 + 6x^{-2}$ or $4x^5 + 6x^{-2}$ or $2x^5 + \frac{3}{2}x^{-2}$. These candidates could still gain the second method mark for appropriate integration. For those who split the fraction correctly, the resulting integration was often correct although marks were lost unnecessarily for example by forgetting to include a constant of integration or for not simplifying fully and writing the answer as e.g. $\frac{1}{2}x^4 + -\frac{3}{2}x^{-1} + c$. There were also other careless mistakes such as missing out '*x*' but writing the index e.g. $\frac{1}{2}x^4 + -\frac{3}{2}\ {}^{-1} + c$ which also cost the final accuracy mark.

Question 4

Overall, this question was well answered by most candidates, with many achieving three of the four marks available. The majority realised they needed to use the discriminant $b^2 – 4ac$, with $b = 6k$, $a = k$ and $c = 5$, although a few used an incorrect expression $b^2 + 4ac$, gaining no marks.

A small number did not square the 6, obtaining an upper limit of 10/3 and gaining the first two method marks only. Most students who had used the discriminant correctly solved the quadratic equation by taking out a common factor, to obtain an answer of 5/9, and made it the upper limit. A few, however, simply solved the quadratic equation, giving no indication that 5/9 was the upper limit, again scoring only the first two marks. Some got very confused when finding the determinant with the k disappearing completely. Often candidates unnecessarily resorted to using the quadratic formula to solve $36k^2 – 20k = 0$. Some just wrote down the answer, possibly using their calculator, which was acceptable here.

Occasionally the discriminant was not used, and the original equation was solved to obtain x in terms of k.

Many candidates ignored the solution, $k = 0$, so the most common error seen was the absence of the lower bound $0 < k$. Many of those who did obtain the correct region including both the upper and lower bounds used a graphical method to do so. Some gave their final answer as $0 \leq k \leq 5/9$, losing the final mark. It was very rare to see the answer given in terms of x instead of k but this error only lost candidates the final mark.

Question 5

Many candidates attempted this question, but a significant number did not. Some who couldn't access part (a) managed to solve the given equation, either by factorisation or use of the quadratic formula to gain the first mark in part (b). Others continued to complete part (b) correctly.

In part (a), candidates who were confident in using indices, had no trouble gaining all 3 marks However, many candidates struggled with this question with some missing it out, although the initial B mark was gained by some for correct use of just one index law. Common misconceptions included, $3^{x+2} = p^2$ and $3^{x-1} = p^{-1}$.

Most attempted part (b) with many candidates gaining all 3 marks. However, a significant number of candidates failed to read the instructions about not relying on calculator technology and showing all working and simply wrote down the solutions to the quadratic and hence received no marks. It is important that candidates heed the warnings given in bold at the start of the question. Some candidates failed to realise they needed to solve the given quadratic in p, whilst some missed out this part or solved the quadratic equation and then stopped, hence only gaining the method mark. Candidates who realised that part (a) was meant to help them with solving the equation proceeded to solve $3^x = 1/9$ and hence $x = –2$. A very few candidates gave a second solution to $3^x = –3$ hence losing the final accuracy mark.

In part (b), some candidates ignored the "Hence" and attempted to solve the original equation in terms of x and could score no marks in this part.

Question 6

This question was generally well attempted. Many fully correct answers with sufficient steps of working were seen, and the majority demonstrated good recall of the required formulae. A few chose to do all of their working in degrees, rather than radians, but this did not result in a great deal of extra working for them in this question.

In part (a), most candidates used the correct sector area formula to find 5.77 m correctly. The most common error was to omit the ½ in the area formula. Just a few lost the second mark as they did not round to the required 2dp or left their answer as an exact expression. A small number made the mistake of taking *AOD* as a diameter and so gave the answer 6.25 m.

In part (b), again most answers were correct. By far the most common mistake was to subtract 2.4 radians from 2π instead of π before halving the result.

In part (c) almost all students used the given value of 40 m^2 for the sector area with a small number unnecessarily calculating it from their *r* and 2.4 radians. The majority were able to recall and use $\frac{1}{2}ab\sin C$ for the triangle area, though some used 5.77 for both sides, which gained no marks. A minority attempted alternative methods such as $\frac{1}{2}b\times h$, usually incorrectly. A few lost the final mark by forgetting to add the 40, to double the triangle area or by giving the answer as 53 m^2, not to the required accuracy of 1 d.p.

In part (d), most students gained the first mark for using the arc length formula correctly. The majority then realised the need to use the cosine rule, with most recalling the formula correctly, though again those who used 5.77 m for both sides could gain no further marks. A few forgot to square root after using the cosine rule. In the calculation of the total perimeter the most common errors were forgetting to double the length *AB*, missing out 12.5, the length of the base, or to include the lengths of the radii *OB* and *OC* in the perimeter.

Question 7

Many capable candidates scored 9/10 for this question, only losing the B mark in (b) for incorrect use of terminology when describing the transformation.

In part (a), most candidates could obtain at least one mark for their sketch of the graph of $y = 6/x$. Many are clearly not taking advantage of the use of graphical calculators as there were many strange shapes and extra asymptotes drawn. Some drew the graphs for both (a) and (b) on the same axes, with unclear labelling making it difficult to be sure what their intention was.

In part (b) it was extremely rare to see a fully correct description of the transformation. Although most knew that the graph would move 2 units right, very few appeared to know that it was a translation, with most using the words ‘shift’ or ‘move’ instead. Some described the translation using vector notation. Many candidates made no attempt at this part of the question.

Part (c) was answered well although a lot of students made this more complicated by equating the expressions for *y* and rearranging into a quadratic before substituting in $x = -4$. More errors in the algebra were found when taking this approach. Many did achieve the correct value for *k* and usually proceeded to a full solution in part (d).

A significant number of students did not attempt part (d). Those who did, used their value for *k* and usually cross multiplied to obtain a quadratic equation. This was then solved correctly either by factorising or use of a calculator. There was some poor algebra seen in many cases, and $6/(x-2)$ was often given as $(6/x) - 3$. A small number forgot to substitute their value for *x* to find the *y* coordinate. Some did not use their value for *k* and tried to use the discriminant, with little success.

Question 8

Many candidates scored full marks in part (a) of this question, with others scoring at least M1 for a correct gradient or *y*-intercept. Some candidates achieved the correct gradient but substituted incorrect values when attempting to find '+ *c*' substituting (4, 12) rather than (4, 0) or (0, –12). On rare occasions, candidates correctly calculated the gradient but then went on to find the negative reciprocal, apparently attempting to find a 'normal'. Common mistakes were incorrectly writing the equation of the line as $y = 3x + 4$ or as $y = –3x + 12$.

Most candidates were successful in part (b). While some used the symmetry of the graph to identify the value of *k*, many found the equation of the curve and solved this to find the value of *k* while in the process, completing most of the work for part (c) at this stage of the question. A common mistake was to identify *k* as –12 or 4 from the coordinates given in the question.

Most candidates who attempted part (c) recognised the structure of a quadratic and gained M1 for working with $A(x – 4)(x – 10)$ or $C(x – 7)^2 – 18$. Candidates who did not recognise the stretch was required, wrote their answers as $(x – 4)(x – 10)$ or $(x – 7)^2 – 18$ and therefore scored no further marks. More successful candidates usually used the minimum point (7, –18) and the equation $y = A(x – 4)(x – 10)$ to find the constant. Some candidates used all three co-ordinates which resulted in setting up and solving three simultaneous equations. This approach often led to algebraic errors and was the least successful approach.

In part (d), most candidates scored at least the method mark for two correct or correct follow through inequalities following through from their linear and quadratic equations in part (a) and part (c). It was common for candidates to lose the accuracy mark for an incomplete solution – usually for providing an incomplete range for *x*, although errors in (a) or/and (c) also prevented access to the accuracy mark in (d). Some candidates provided inequalities in terms of *R* which scored 0 marks. Candidates were generally consistent in their use of inequality signs.

Question 9

A relatively small number of candidates achieved full marks in this question (< 5%) and more than half of all candidates scored no marks. Approximately 10% of candidates did not attempt this question. The most common score, other than zero, was 1 mark, with a small few scoring 2, 3 or 4 marks. Sometimes only one part of the question was attempted. Use of the given graph seemed to have helped many candidates arrive at a solution and on a number of occasions a solution was attempted several times.

In part (a), less than half of all candidates gave a correct answer for the period of tan *x*. A slight majority of these gave the answer correctly as π rather than $180^o/180$. Occasionally the period was given as 'π or 180^o. Quite frequently the answer was given as an interval, including $–\pi/2 < x < \pi/2$, which might have led to the correct answer had it been pursued further. Other intervals quoted include $–\pi < x < \pi$, $–180 < x < 180$ and $–2\pi < x < 2\pi$. It is possible that this type of answer arose through a confusion between period and domain/range. Other common incorrect answers were 0, 2, $(3/2)\pi$, 2π, 4π and 90^o. Sometimes large numbers were involved e.g. 2056.

In part (b) it was rare to see all three marks scored. Even where candidates drafted the shape of the curves beyond the original drawing it was not certain that they would then state the number of roots correctly for parts (i) and (ii). Also, if the answer to (i) was correct it did not automatically follow that (ii) would be correct as well, as the most common total in part (b), other than zero, was 1 mark. Sometimes a correct answer to (ii) would follow an incorrect answer to (i), with an occasional correct answer in (iii) as well. It was usual to see the answers increase in size as the solution progressed, but there were some exceptions.

Common incorrect answers to part (i) were 1, 2 or 4, whilst common incorrect answers to part (ii) were 3, 4 or 6. Incorrect responses to (iii) were usually multiples of 50 or 100. Several incorrect sequences of results were observed within the candidate responses to part (b). The most popular being (1 or 2, 4, 200) and (1, 6, 300). It is possible that the (2, 4, 200) may have arisen from the candidate overlooking the point (0, 0). Usually, a correct answer of 201 in part (iii) was arrived at without any clear method seen.

Question 10
The majority of candidates scored at least four marks in this question. This was largely due to the accessible 3 marks in part (b) for expanding the 3 linear brackets. However, around 5% of candidates gained zero marks, either from incorrect work throughout the question or because no part was attempted.

In part (a) approximately one-third of candidates scored both marks. Of those who scored just one mark it was usually for writing $x > 3/2$ together with an error such as $x > –6$. Some responses had inequality signs used incorrectly e.g. $–6 < x < –20/3$. Both marks were lost by a large proportion of candidates who wrote down one or more critical values only, not realising that inequalities were required. A number of candidates did not answer this part of the question.

Candidates were generally more successful in part (b) of the question and more than two-thirds scored all three marks. Often, simple arithmetic errors lost them a mark e.g. evaluating $6\times3x$ as $9x$. The most common error was in the final coefficient of the x term. Occasionally the final accuracy mark was also lost due to the candidate dividing the required expression by 6 at the end. All three marks were lost by the few who only used two of the brackets or engaged in some other mismanagement of the brackets.

Approximately one-third of candidates scored full marks in part (c). A substantial number either gained zero marks for their work or made no attempt at this part. Those who lost the marks generally tried other (incorrect) approaches and did not think of differentiating. After differentiating, incorrect work usually came from the insertion of a value other than $x = 0$ into dy/dx. Sometimes f(0) or f″(0) was used. On occasion the candidate tried to solve f′(x) = 0. Of those who differentiated without evaluating at $x = 0$, some then proceeded to find the discriminant of the derivative. Instances were seen where the –360, on each side of the equation formed, were not cancelled, but resulted in a term of 720 being carried forward in the solution. Some candidates extracted a factor of x rather than x^2 and then solved the equation using the quadratic formula and gained the correct answer. Sometimes there appeared to be a lack of momentum and the solution stopped before the final stages were engaged, commonly after determining the equation of the line l.

Question 11
Different parts of this question proved challenging for many candidates, although most were able to gain some credit and there were some eloquent solutions.

Part (a) was sometimes missed out completely. Where it was attempted, the gradient of the normal was often correctly stated, but some candidates seemed unsure how to proceed further or simply gave the answer as $y = –1/3x + 4$. Those who did realise they needed to find coordinates for P were usually completely successful, often using $y = mx + c$ and substituting.

Some candidates incorrectly used the gradient of the tangent instead and hence lost both marks in this part of the question.

Part (b) saw a very mixed response. Most were able to integrate $f''(x)$ successfully, although a few succeeded with the indices but struggled with the coefficients. The common errors were to forget to add a constant of integration altogether or to include it, but not attempt to calculate it for $f'(x)$. Those who did attempt to find their constant were often unsuccessful because they substituted the coordinates for $P(4, 16)$, or sometimes (4, 0) rather than realising $f'(x)$ is the gradient function so that $f'(4) = 3$ was needed. Most did continue to integrate their $f'(x)$ to find $f(x)$, substituting the coordinates for P however, for those who had lost a method mark earlier in this part of the question, the final method mark was unavailable. A few who had successfully found the constant of integration for $f(x)$ made arithmetical errors when substituting (4, 16) into a correct equation thus losing the final mark. The most commonly occurring mark profile in part (b) was 100100. Very few candidates achieved full marks.

It was very common to see candidates integrate twice and apply a constant only after their second integration, thus missing earlier marks.

Some candidates may have run out of time as there were a number of candidates who did not attempt Q11.

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