Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2024

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

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General Comments

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 and the questions that proved to be the most challenging were 9, 10(b) and 11.

Presentation was generally good and candidates often showed sufficient working to make their methods clear. It does need to be stressed however that candidates should take careful notice of the warning in bold, when given, at the start of a question, not to use a calculator. Question 2(ii) was a particular case where this warning was given yet candidates clearly used a calculator to simplify their fractions rather than showing the work to rationalise the denominator.

Question 1

This was generally well answered. There were few notational errors such as spurious integral signs and d*x*'s seen in the final answer. Very few candidates differentiated. Candidates knew to raise powers by one and the vast majority scored 2 marks or more. The second term was the term that they found difficult. Some struggled to write as a negative power before integrating and others lost a negative resulting in $-\frac{3}{4}x^{-2}$. The + *c* was usually present and few lost marks for omitting it. Centres need to ensure candidates have plenty of practice at integrating negative powers.

Question 2

This question was often split into those who were competent in indices or surds although a small minority gained full marks on both parts.

Candidates sometimes struggled with (i) part (a) and failed to see the connection with powers of 2. Some left the answer as 2^3m instead of simplifying to $8m$. The most common wrong answers were m^3 or $m + 3$.

In (ii) part (b) a significant number of candidates failed to re-write 16 as a power of 2 and hence lost both marks. However, some managed to write the expression as a power of 2 but were unable to proceed correctly. The most common wrong answer was 4096*m*. Some wrote the answer as a power of 4 which scored no marks.

In part (ii), many candidates were able to collect x terms to one side, factorise, make x the subject and rationalise the denominator. Unfortunately, a small minority of those, lost the final mark due to failing to show the rationalisation or the expansion of the numerator in order to demonstrate non-reliance on calculator technology.

Those who could not rearrange generally made no significant progress towards the required form. A significant number of candidates did not show the working for rationalising the denominator and hence lost the final two marks. The question specifically said that all stages of working should be shown. There were occasional instances of alternative methods; mainly squaring both sides which sometimes generated extra solutions. Many lost the accuracy mark as they didn't show intermediate steps - at least one was needed. Candidates need to make sure that they show each step of their working clearly.

Question 3

In part (a), the majority of the candidates were able to draw a translation parallel to the x axis. However some candidates did not score the first mark as their x-intercepts contradicted a translation and suggested a stretch. Some candidates failed to recognise that they needed to indicate the coordinates of points of intersection with the coordinate axes and hence lost marks even though their graph did appear to be correct.

In part (b), the majority of candidates identified the correct transformation. However, most candidates drew the maximum turning point on the y-axis or in the first quadrant rather than in the second quadrant. A significant proportion of candidates did not identify the correct transformation but were able to score the final marks as their curve passed through the correct points.

Question 4

There was a mixed response overall to this question.

In part (a), most were able to equate the given curves for the first mark although there were many who made careless sign errors or who did not include the "= 0". A significant number did not proceed any further but those who did, almost always attempted the discriminant. Although the formula was well recalled by most, there were often errors in its application with some unable to obtain *b* and *c* in terms of *k*. A common error was mishandling the $-9-k$ which was often seen as e.g., $-(9-k)$. As a result the awarding of full marks was not particularly widespread. A small number missed the "= 0" in their final line.

In part (b), the correct value of *k* was widely obtained by the usual various methods although $k = +13$ was seen on occasion. There were quite a number of confused attempts – many thought that the -13 was the *x* coordinate. Others substituted -13 into one of the curves rather than the equation of intersection of the curves. Some unnecessarily repeated the curve-equating work in part (a). Those that achieved a quadratic by the correct method were usually able to score the quadratic solving mark. A small number did not proceed to find the *y* coordinate. However there were a significant number of responses where $(-1, 21)$ was achieved quickly and efficiently.

Question 5

The majority of candidates gained at least the method mark in part (a) for using a correct formula to find the area of the sector. It was usual for the correct unit of area to be included. Incorrect units of area were rarely seen, if at all. The majority used the standard formula $\frac{1}{2}r^2\theta$ with a few applying a correct fraction to πr^2. The most common form of a correct answer was 23.4 with a small proportion writing it as $\frac{117}{5}$. Errors in method were usually a result of an incorrect formula such as $r\theta$, $\pi r\theta$, or θr^2. A few used πr^2 without an adjustment.

Most candidates made a good attempt at part (b), often scoring both marks. The method mark was for a correct numerical application of the cosine rule for the required angle. Those who worked out angle *EAB*, but did not realise it, scored no marks. On the occasions that the final mark was lost, it was usually because the answer was given in degrees and not converted to radians at any stage, or arccosine was not used at the end. Some quoted the cosine rule, either or both versions. Errors in method included misquoting the cosine rule, using the sine rule without an acceptable angle, and using Pythagoras.

A pleasing number of candidates gained the first method mark in part (c) by using a correct expression for the area of triangle *ABE*. Although there were various methods to find the area of triangle *BCD*, the majority of candidates found *BC* and *CD* by the appropriate use of trigonometry, or a combination of trigonometry and Pythagoras in triangle *BCD*. These usually went on to use a correct formula for the area. Some however used the formula $\frac{1}{2}$ base×height with the side *BD*, losing the last two marks. Some used a full sine rule, often using angle *BCD* as 90° with their angle *CBD* in radians. Again, these attempts would lose the last two marks. Errors in the final area were often from a miscalculation of angle *CBD* but the method marks could still be gained for the correct method for the area of triangle *BCD*. Some students also found one length of this triangle and then correctly used Pythagoras to find the other. Too many candidates lost the final accuracy mark due to rounding and truncation errors in their calculations. However, there were many fully correct solutions seen.

<u>Question 6</u>

Nearly all candidates gained the first method mark in (a) by equating the equations of the line and the curve to obtain a 3-term quadratic in x. However, although very many fully correct coordinates for P and Q were seen, many candidates lost 2 marks by not reading the instructions in the question and used their calculators to solve the quadratic $2x^2 - 4x - 96 = 0$. Those who factorised this quadratic as $(x - 8)(x + 6)$ unfortunately lost the second method mark and the final accuracy mark. Those who gained the full 4 marks showed either a correct factorisation of this equation as for example $(2x - 16)(x + 6)$ or reduced the quadratic by dividing by two first and then factorised. Many also used the quadratic formula to find the roots. Unfortunately, some errors were seen within the formula and were not recovered sufficiently to show that a calculator had not been used. This was usually by writing -4^2 and not then showing the correct value for the discriminant in the formula. Very few made an error with the corresponding y values.

Generally, in part (b), candidates often missed just one of the inequalities required, and this usually was the restriction on x. Errors were sometimes made in saying $y > 2x^2 + x - 21$ or

$x > 0$. Very few students stated R instead of y which was good to see. A few candidates lost the accuracy mark by adding an extra inequality, which usually was involving y. Full marks were available for the consistent use of strict or non-strict inequalities and only a few candidates mixed these within their solution. Most candidates scored one or two of the available marks, with very few gaining full marks.

Question 7

The majority of candidates answered part (a) well, scoring full marks for fully correct differentiation. A small number of candidates integrated instead, gaining no credit. A few candidates made numerical processing errors when differentiating and some incorrectly 'simplified' their expression in (i) by, for example, dividing by 2, which then led to errors later on.

In part (b), most candidates were able to set their $f'(x) = f''(x)$, although many struggled with the next step. Many candidates did not realise the need to substitute $x = 5$ into this equation, and either stopped at this point, or attempted to find the discriminant – gaining no marks. Of the candidates who did substitute in correctly, many went on to correctly find the value of k. Others made numerical processing errors along the way, resulting in an incorrect value for k. Some candidates substituted $x = 5$ into either $f'(x) = 0$ or $f''(x) = 0$ and solved this equation, again scoring no marks.

Many students struggled to identify a correct strategy in part (c). Mistakes were common in this part and included: substituting their value for k into one equation only, setting it equal to 0 and solving; setting $f'(x) = f''(x)$ and solving, but making errors when rearranging; using a correct method, but working with an incorrect value for k; finding a value for x but then substituting this into the original equation to find y (or even their simplified equation for $f'(x) = f''(x)$), rather than $f'(x)$ or $f''(x)$.

Question 8

A mix of graphs were seen from candidates in part (a). Most were able to produce a cubic graph (whether positive or negative), but straight lines, quadratics, quartics, and cubics with a point of inflection were also seen on occasion, as well as other, less well-defined shapes. Many candidates recognised the importance of the graph passing through (0, 0), but mistakes were often made by incorrectly identifying this as a turning point.

Most candidates gained the mark for part (b) of the question, rearranging correctly and showing sufficient working. Of those who didn't, a common mistake included forgetting the '= 0' at the end. Candidates who were unclear on the correct approach to this kind of question, based their work on the final answer they were attempting to reach; for these candidates it was common to at some point see $x^4 - 4x^2 = A$ (with the negatives incorrectly placed). A very small number of candidates also started with the final answer and attempted to rearrange, but mistakes were often made and this approach gained little credit.

Most candidates recognised the need to use the discriminant in part (c), with varying degrees of success. Most used the correct values for a, b and c, although a few misidentified the coefficients. Candidates often struggled to identify the correct inequality, with $A = 4$ and $A > 4$ seen regularly. A few attempted to solve the equation using the quadratic formula but did not reach a value for A, so scored no marks. A number of students found a value for A but then incorrectly attempted to solve the resulting quadratic and identified x as lying between $\sqrt{2}$ and $-\sqrt{2}$. Very few candidates recognised the need for a lower limit for A, and fully correct answers were rare.

Question 9

Although there were many fully correct responses to part (a), marks in parts (b) and (c) proved quite hard to come by for many.

A correct gradient was achieved by most in part (a) although there were some attempts that added the coordinates or attempted to use the difference in x divided by the difference in y. A very small number attempted a normal gradient. Most were able to form a straight line equation appropriately via various methods. As is usual, those using $y = mx + c$ were slightly more prone to error. Use of simultaneous equations was fairly rare but usually correct. Many fell foul of sign slips and occasionally the quadratic was not given with integer coefficients or the "= 0" was omitted.

Part (b) saw many confused or cursory attempts. Some just calculated the length of AB. Many students seemed to benefit from drawing a decent sketch. A common error was to see the line $y = 4$ used instead of $y = 2$. Those that could produce an equation in x from the start tended to be more successful than those who used e.g., "CD" for $15 - x$. Pythagoras wasn't always applied correctly and it was quite common to see poor squaring. Those who did progress usually did so via a 3-term quadratic equation, although some students were able to spot that bracket expansion was unnecessary. Those who had obtained the correct equation were almost always able to find both of the correct possible positions for C.

Part (c) was often not attempted and it certainly wasn't always the case that students who had achieved full marks in (b) went on to get both marks in (c). There were many efforts where the lengths AB or CB were used for the perpendicular height of the triangle. A small number found the maximum area of the triangle. A few shoelace method attempts were seen but had mixed results. There were also a few attempts that needlessly used trigonometry but these tended to be correct methods, although a small number rounded prematurely leading to an inexact answer.

Question 10

In part (a), most candidates successfully found the gradient. However, a significant proportion of candidates were unable to evaluate the fractional powers when evaluating the gradient. Most candidates successfully found the negative reciprocal to achieve the gradient of their normal which was then used to find the equation of the normal using an appropriate method. Occasionally candidates found the equation of the tangent and not the normal.

In part (b), most candidates failed to apply the minus in front of the fraction component when simplified. However, most of these candidates went on to correctly integrate by increasing at least one correct fractional power and in combination with the $6x$ term being successfully integrated attracted all but two of the available marks. Some candidates having simplified the fraction, omitted the preceding term and did not achieve any correct terms. Most candidates were able to use $f(4) = 12$ in their answer to the integration to determine the constant.

Question 11

Parts (a) and (b) were well attempted by all candidates. The answers were required in radians and it was disappointing to see candidates giving some or all coordinates in degrees.

In part (a), many candidates correctly spotted that $y = 12$ but the most common error was giving the angle in degrees. A few wrote the coordinates the wrong way round.

In part (b), there were a number of incorrect values for the y coordinate such as 12, 21 and -3. Some candidates also incorrectly stated that $x = \frac{3\pi}{4}$ or 270 degrees.

In (c)(i), a significant number of candidates were able to obtain the correct value for A as -12, but many had the wrong answer of 12. Some lost the mark here for failing to identify their answer as A, leaving their solution in coordinate form.

Part (c)(ii) was not well answered. It was quite common to see candidates correctly solve $\sin^{-1}\left(\frac{A}{12}\right) = x + B$ with $x = \frac{\pi}{4}$. Some candidates achieved $-\frac{3\pi}{4}$, but did not add 2π to obtain the correct answer. It was a common mistake to see $\frac{3\pi}{4}$ as an answer to this part of the question. There were a small few who wrote $\frac{\pi}{4}$ due to incorrectly adding π. Some candidates failed to attempt part (c) at all.

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