Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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In Pure Mathematics (WMA12) Paper 01

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General Comments

This paper proved to be a good test of candidates' ability on the WMA12 content and plenty of opportunity was provided for them to demonstrate what they had learnt. Marks were available to candidates of all abilities

In general presentation was very good. The candidates often showed all the work required using appropriate mathematical notation. It was noticeable however, that some of the stronger candidates, missed out some of the required steps in some questions. This was particularly the case in Q6, where a significant number of candidates failed to combine logs before reaching an expression without logs, despite being asked to show all stages of their working. It is worth stressing that candidates must show every step in this type of question and not leave the examiner to "fill in the gaps".

There were a small number of candidates who appeared unprepared for this assessment, but they could generally gain marks in 4(a) and c(i) for differentiation, Q6 on logs and Q10(a) for finding the centre and radius of a circle. Most candidates were also very adept at the binomial expansion and most gained the 3 marks in 5(a). Q8(a) was also accessible to most candidates, as was the integration in Q8(b) and Q9(a) also seemed very accessible to most candidates with often only a minor slip in notation losing them the accuracy mark.

Accuracy was sometimes an issue. This was particularly in true in Q7. It was rare to award the B1 in part (a) as most candidate gave the answer as 69.5 not appreciating the context of the question. Few candidates used exact values in part (c) and again it was rare to award the final A1 due to loss of accuracy.

Many candidates appeared unfamiliar with the term "quotient" in Q3(c). The final A1 was awarded very rarely as candidates weren't sure what to give as the answer.

The questions that candidates found hardest were the ones that required candidates to apply their knowledge in an unfamiliar context. Candidates found Q2 difficult, and many misinterpreted the recurrence relation. Candidates also appeared to be unfamiliar with some topics and there were a surprising number of candidates who could not apply the trapezium rule correctly in Q1, either due to an incorrect strip width and/or incorrect bracketing. There was evidence in Q4(ii) where some candidate appeared not to be familiar with the process of determining the nature of a stationary point.

Question 1

This was a nice start to the paper with the first three marks being a straightforward trapezium rule question. Part (b) was more challenging, this required candidates to recognise they needed to integrate $4x$ between 0.5 and 5.5 and add the resultant value.
In general, part (a) was done very well, with the majority knowing how to use the formula, including using brackets appropriately i.e. a set of brackets within another set. Generally, errors occur in two places. Firstly, where a set of brackets is missing and secondly when the width of the trapezia is incorrect. It should be made clear that the width of the strips is the difference between consecutive x values. A significant number of candidates had an incorrect strip with of 1.

The nature of the demand in part (b) was familiar and candidates knew they had to split the integral so that they could use their answer to part (a). The integral of $4x$ was often done well, leading to $2x^2$, with values substituted in, resulting in a correct answer. Problems arose when the integral of $4x$ was simply not found, and instead 5.5 and 0.5 were substituted into $4x$ itself. If part (a) was incorrect, full marks were still available in part (b), if this was done correctly, due to the follow through accuracy mark.

Question 2

In part (a), most students were able to successful use the recurrence relation however there was a significant number who used $n + 1$ rather than n as the power of -1, leading to an incorrect sequence and only scoring the method mark. This led to a loss of marks in parts (b) and (c). A minority of candidates attempted to find a value of k in this part of the question, by an incorrect method such as setting $u_2 = 0$. This then limited marks available later in parts.

Most candidates had a correct method in part (b) and added their first 4 terms together, equated to 30 and obtained a value for *k*. A few candidates added five terms instead of four and scored zero marks for this part of the question.

Success in part (c) was very mixed. Those who used the sum of 4 terms is 30 had the easiest route although a few forgot to add the extra two terms or worked out 37.5 × 30. Several worked out the value of each term and worked 37×by the total or 37 × by each individual number, but they normally added the extra two correctly. The marks for part (c) were only available to candidates if their sequence was of order 4 so some could not access either of the marks for this part. Many arrived at the answer of 1125. Typically, candidates opted to do $37 \times 30 + u_1 + u_2$ but some used alternate methods too. Some incorrect attempts included the use of the sum formula for an arithmetic or geometric series.

Question 3

The majority of candidates scored full marks using the remainder theorem, consistently finding f (–3) as and setting that equal to 55. There were very few instances of the use of f (3). There were a few attempts using more time consuming tabular or division methods and these were carried out with mixed success as a complete method was required for the method mark, so candidates needed to carry out their division to obtain a remainder in *A* and *B* and set it equal to 55. The subsequent rearrangement was sometimes poorly presented with the use of multiple arrows to indicate moving multiple terms from one side to the other. Candidates should be encouraged to use several steps, rather than try to do everything at once. This should also remove the need for the arrows. When the final accuracy mark was lost, it was usually due to sign slips or miscopying the given equation.

In part (b), candidates usually used the factor theorem and consistently found $\text{f}\left(\frac{5}{2}\right)$ and set this equal to 0, there were very few instances of $\text{f}\left(-\frac{5}{2}\right)$. Again there were a few attempts using more time consuming tabular or division methods and these were carried out with mixed success. There was an equal split between those who subsequently solved simultaneous equations by calculator or manually. Manual solutions sometimes suffered from errors when rearranging.

In part (c), there was a clear lack of understanding of the meaning of 'Quotient'. On balance, slightly more candidates chose to divide by (x - 7) than calculate f (7). However, of those who chose division, while the division was generally done accurately, only a very few clearly identified the quotient appropriately. It was not uncommon for the long division to be performed correctly but the remainder selected as their answer, many even stating "quotient = 495", or the function written as a product of the linear and quadratic expressions with a remainder with no indication of which part was the quotient.

Question 4

The first two marks, for a correct differentiation, were achieved by the vast majority and there were few errors here.

Part (b) however was generally not done well. Candidates knew to set their derivative = 0 but could not then choose an appropriate method for solving the resulting equation. When it came to finding the second derivative in part (c) again this was done well.

When attempting to classify the turning point, candidates did not always substitute the value found in part (b). If they did, and found a positive value, candidates usually knew this signified a minimum point although some candidates lost a mark unnecessarily as no reference was made to the positive nature of the value of the second derivative. Sometimes the second derivative was set = 0 and the resulting equation solved.

Candidates were usually more successful with part (d) and a follow through mark was available. It was pleasing to see that candidates clearly understood the nature of the graph and how to interpret the minimum point and how it relates to where the graph is decreasing. Incorrect attempts often used the value of the second derivative in the inequality.

Question 5

In part (a), most candidates were able to attempt the Binomial expansion with many being successful. The majority had the correct structure of the expansion, correct coefficients and managed to gain at least one mark on their initial line of working. However, there was a minority of candidates who did not use brackets appropriately and often went on to lose at least one accuracy mark. There were some calculation errors with the coefficients, but the most common error was a failure to deal with $(ax)^2$ correctly by either leaving the brackets, thus not in simplest form, or not squaring the '*a*'. Very few candidates gave their final answer as a list of terms instead of the normal sum of terms. Only a small number of candidates chose to take the 2 out as a common factor and, for the most part, dealt with the factor effectively but struggled to deal with $\left(\frac{ax}{2}\right)$ accurately in each term.

Part of the question proved much more challenging. Some candidates struggled to properly interpret the information regarding the constant term and did not identify all or any of the constant terms in their expansion. When dealing with the squared bracket in the question, a minority of candidates ignored the index and just multiplied by $\left(3+\frac{1}{x}\right)$. Others struggled to accurately square the bracket, often with the reciprocal term incorrect. The better candidates, once the bracket had been expended, could identify the constant terms without multiplying out all six terms. There was some confusion with the 576 being one of the constant terms and their sum. Once the constant terms were identified correctly and set = 576 the method was relatively straight forward and only those candidates who then found $a = 0$ and did not reject it, lost any marks. A few candidates found $x = \ldots$ rather than $a = \ldots$ thus also losing the final accuracy mark.

Question 6

The rubric of this question emphasised that **all** of the steps in the working needed to be shown. Solutions where the mechanism for combining the log terms were not shown could not gain full credit and a significant number of candidates fell foul of this and lost unnecessary marks.

The majority of candidates scored the first mark by correctly rewriting $2\log_4(x + 1)$ as $\log_4(x + 1)^2$ and then proceeding to combine two logarithmic terms. They then removed logarithms to achieve an equation which led to a three term quadratic. This was solved correctly in most cases, but the final mark was frequently lost by those who did not reject the negative root, which was not a solution of the original equation.

There were some instances of incorrect logarithmic work such as $\log_4(12 - 2x) - \log_4(x + 1)^2$ becoming $\frac{\log_4(12-x)}{\log_4(x+1)^2}$ and, as with the omission of the required combination of logs, did not score the first method mark. It was pleasing to see that incorrect log work such as

$\log_4(12 - 2x) = \log_4 12 - \log_4(2x)$ was seen only rarely.

An alternative approach of rewriting the given equation as $4^{\log_4(12-2x)} = 4^{2+2\log_4(x+1)}$ was seen occasionally and received credit if processed correctly.

Question 7

A number of candidates omitted this question, possibly due to the amount of text to read and the level of interpretation required.

Those candidates who had learnt the formulae for arithmetic sequences scored well on parts (a) and (b). However, in part (a), a significant number showed correct working but left the answer as 69.5, not interpreting the value from the calculation as an amount of money. A minority of candidates started with given solution £69.50 and attempted to show that this was the amount in month 100 but again did not score unless this was accompanied by a minimal conclusion.

In part (b) the majority used either of the correct sum formulae to find the sum of the 300 terms. Most formulas for the sum of an AP were correct with correct values substituted although some candidates incorrectly had "$2a(n-1)d$" in their formula bracket so did not score. Occasionally n = 100 was used in one of the substitutions for n in the $\frac{1}{2}n(2a+(n-1)d)$ formula, possibly taking this value from part (a). A significant number of candidates calculated the 300th term rather than the sum of the first 300 terms or tried something totally incorrect, such as a geometric series formula.

In part (c), most candidates recognised that the second savings scheme formed a geometric series. The correct strategy for finding r and then the sum of the first 300 terms was common. Those candidates that did use the GP formula for the n^{th} term, struggled with the algebra and method required to find r. Those that found r usually did so using the index 1/299 or the 299^{th} root. A few candidates wrongly had 300 as the index in their formula for n^{th} term. Many candidates usually went on to correctly find the sum of the first 300 terms of a GP and use their answer to part (b) to calculate the difference. It was only a minority of candidates who gained the final accuracy mark as any rounding of r (even to 5dp) or failure to round the final answer, after using a sufficiently accurate value for r, did not generate the required answer.

Question 8

In part (a), candidates usually began correctly by equating the two curves. Most then continued to multiply both sides by x^2 to obtain a quadratic equation in x^2. Those who did not do this usually did not make any further progress on the question. Some failed to multiply correctly and some neglected to rearrange to give a 3 term quadratic, which meant that appropriate solution techniques were not used. The majority of candidates who achieved a 3 term quadratic were able to solve to find the appropriate values of x. The most common solution method was factorisation although a few did use the quadratic formula. Unfortunately a significant number of candidates did not clearly show their working as indicated in the question. Instead they relied on calculator solutions and just stated the roots. These could not be awarded the relevant method mark. Candidates who substituted for x^2 and solved the quadratic generally had greater success, however a minority did forget to transform their results back to x. Once the values of x were found, the candidates correctly selected the positive values. Candidates often went on unnecessarily to find the y values. Solving the original equations simultaneously via y was extremely rare but was usually executed very efficiently.

Part (b) was often done well with the correct integrals set up and the integration being correct. However, some candidates did try to integrate the quartic found in (a) which was an incorrect method and so could not be given any credit. When integrating the correct functions, the most problematic term was the term with the negative power. Another source of error was with the subtraction/addition of terms due to sign errors when removing brackets. In general, it seemed that the more popular and successful method was to integrate each function separately and find the difference as opposed to subtracting the quadratic function from the other function first. Candidates almost always correctly chose to use the values of x found in (a) as their limits of integration. There were some errors with the substitution and evaluation so candidates should be encouraged to clearly show the substitution process so that their correct methods can achieve credit. A small number of candidates presented their final answers in decimal form rather than the required exact form. Some candidates subtracted the wrong way round and therefore obtained a negative result. Those who recognised that their area should not be negative were awarded the final mark if they reverted to the correct positive value.

Question 9

Most candidates achieved full marks in part (a). The identity $\tan\theta = \frac{\sin\theta}{\cos\theta}$ was used together with the Pythagorean identity $\cos^2\theta = 1 - \sin^2\theta$ in order to achieve the printed result.
The final accuracy mark was sometimes lost when notational errors were seen. The most common was to see $\sin^2\theta$ written as $\sin\theta^2$ or $\cos^2\theta$ written as $\cos\theta^2$ but there were also some cases where expressions were written incorrectly such as $\tan\theta = \frac{\sin}{\cos}\theta$ and $\cos^2 = 1 - \sin^2$. There were some incorrect identities seen, in particular $\cos\theta = 1 - \sin\theta$ and $\cos^2\theta = \sin^2\theta - 1$. There were instances where the final result had a sign error in it despite being preceded by fully correct work and despite the result being printed on the question paper. An alternative approach working backwards from the given final equation to the initial equation was rarely seen but gained full credit provided that there was a final conclusion.

Part (b) was less well answered, and it was common to see the final accuracy mark lost. The solution of the three term quadratic equation from part (a) was usually successfully completed but there were occasions where a candidate used an incorrect quadratic – usually with a sign error – and these gained no credit. Surprisingly, some candidates thought the solutions to their quadratic equation were values of *x* and not sin *x*, and so didn't find the inverse sine, and just subtracted $\frac{\pi}{3}$ and divided by two. Most attempts that did use inverse sine, used the relevant root and then correctly found one solution of the equation using the correct order of operations. There were attempts to work in degrees which were usually unsuccessful as the $\frac{\pi}{3}$ was left unchanged rather than becoming 60°. Candidates found it difficult to generate all of the required roots with most only giving two solutions out of the four required. The most common omissions were the 3.02 and/or -2.50. Correctly rounding to three significant figures also caused loss of marks, presumably due to premature rounding.

Question 10

In part (a), the majority of candidates were able to successfully convert the equation to the standard form of a circle and extract the coordinates of the centre and the radius. There were occasional errors with the signs of the centre coordinates. Arithmetical errors when completing the square did lead to finding an incorrect radius on occasions. Some candidates with correct equations incorrectly interpreted it to find the radius and either failed to square root or mistakenly squared. Some candidates wrote down the centre of the circle without showing any working. This was condoned as long as the coordinates had the correct magnitude. However, this strategy does risk being awarded zero marks if an error is made.

Part (b) was more challenging for candidates. Many substituted $y = mx + 1$ into the equation of the circle to obtain a quadratic in x but then did not know how to proceed. Some mistakenly equated their equation of the circle to $mx + 1$ which left them with an equation still in terms of both x and y. Those that recognised the need to find the discriminant of their quadratic in x sometimes made errors when expanding to find the coefficients. Some failed to equate the discriminant to zero. However, there were some good attempts to find their quadratic in m and simplify it to the given equation. The alternative method which considered the perpendicular distance from a point to a line was not often seen and those that did attempt it were rarely successful. A significant number of candidates omitted this part of the question.

In part (c), the majority of candidates were able to score the first method mark for the correct solution to the quadratic equation in m. It was very rare to see errors in this solution. Some showed the factorisation of the quadratic, but the majority stated the roots suggesting that calculators were used. Some candidates did not progress any further. However, many did attempt to proceed by substituting $y = mx + 1$, using their m, into the equation of the circle and proceeded to solve the resulting quadratic equation it to find x. Unfortunately, some candidates did not follow on to find y to determine the coordinates. Also, some algebraic errors caused candidates to lose accuracy. A substantial number of candidates forgot to repeat the process with the second value of m to find the other pair of coordinates. A rarer solution method was to find the intersection of the tangents with the perpendiculars. Those who attempted this approach generally found the equations of perpendicular lines correctly and could at least score both method marks and if they were careful with the algebra, often went on to obtain the correct coordinates.

Question 11

Part (a) of the question was well done with most candidates successfully substituting prime values of n until they found one that did not give a prime answer. However, some failed to score the accuracy mark for non-existent or poor conclusions. A few candidates used values of n that were not prime, with $n = 1$ being the most common incorrect choice for n. There were also some errors in evaluation and some erroneously identifying calculations such as $3^3 + 2 = 29$ as non-prime. Most candidates used $n = 5$ to produce $35 + 2 = 245$ and scored both marks by either stating that this was non-prime or by showing that it was, for example, divisible by 5 and so the statement was not true.

In part (b), less prepared candidates generally substituted in numerical values for m or left this part of the question blank and scored no marks. Some candidates had clearly done similar proof questions using odd and even algebraic generalisations and therefore tried to use those here and failed to score any marks. Those candidates who found a suitable algebraic generalisation often went on to substitute and simplify correctly gaining the first two marks ($3k + 1$ being most common of these). Stronger candidates also found another generalisation which covered all integers not divisible by 3 and again substituted and simplified accurately. Most candidates, who got this far, factorised out 3 correctly or demonstrated divisibility by 3 but some candidates obtained a correct expression but did not give sufficient justification that it was divisible by 3 to gain the accuracy marks. Some only considered one of the cases where m is not divisible by 3 and so only gained the first 2 marks. Some candidates obtained a correct expression but did not give sufficient justification that it was divisible by 3 to gain the accuracy mark. There were also occasional algebraic slips, or a missing overall concluding statement which resulted in loss of the final mark. Only a few candidates continued to use m in their generalisations, which also lost the final mark if the proof was otherwise correct. It was a shame in some cases that a final conclusion was not made when preceded by fully correct work. A small number of candidates used more than two correct generalisations in their method, thinking they had not covered all possibilities, and some candidates used the same generalisations such as $3k - 1$ and $3k + 2$ which generate the same numbers instead of selecting exhaustive expressions such as $3k + 1$ and $3k - 1$.

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