Examiners' Report
Principal Examiner Feedback

Summer 2019

Pearson Edexcel International A Level
In Pure Mathematics P2 (WMA01/01)

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General

This was the first WMA12 paper under the new specification. The paper had a variety of very accessible and familiar questions such as 2, 4a, 5a, 6 and 10b, as well as ones that tested both the new content and the more demanding areas of the specification. Question 2 tested proof which is new to the IAL content and questions 1, 7, 8 and 9 proved to be very discriminating. The paper was of an appropriate length with little evidence of candidates rushing to complete the paper.

Points to note for future exams are

- Candidates should write down a formula before attempting to use it. This was particularly relevant in question 7.
- Candidates should take care when reading a question. For example in question 5 many found the value of *x*, not the value of *P* as demanded by the question. Also in question 6b, many candidates did not **fully** factorise their expression.
- Candidates need to be careful to show all the steps in "show that" questions. This was not only true in question 2 but also in 4b, 9b and 10b .

Question 1 (Mean Mark 2.2 out of 4)

This appeared to be a difficult opening question for a significant number of candidates. Most answered part (a) (i) correctly but many struggled with the pattern required to identify a_{107} . Too often candidates assumed that the sequence was an arithmetic and found $1+106\times 2$. Where candidates did form a few terms of the sequence, they achieved full marks in part a

Part (b) proved a very good discriminator. Where candidates had spotted it was periodic, they usually achieved full marks. The better candidates had little difficulty evaluating the correct result, mostly using the sum of the odd and even terms of 5 and 1 respectively, then multiplying by 100. However, part (b) proved beyond the weaker candidates, who either made no attempt or else tried to apply a sum formula for an AP or GP, thus gaining no marks.

Question 2 (Mean Mark 5.5 out of 7)

This question was familiar to most and as a result was well answered with very few problems.
In part (a) most candidates could complete the square accurately, although a few made sign errors. Those who found the centre by just considering the $4x$ and $-10y$ more often than not had incorrect signs. Slips on finding the value of *r* seemed more common than usual.
For part (b) nearly all candidates found the gradient of the radius accurately; just occasionally it was "upside-down", and there were a few sign errors. The fact that a co-ordinate of 5 appeared twice was slightly confusing to many. Nearly all then found and used the perpendicular gradient accurately to find the equation of the tangent. Some candidates attempted this part by implicit methods but few were successful.

Question 3 (Mean Mark 2.0 out of 4)

This questions tested "proof" which is new to the IAL specification. In part (i) it was found that few candidates really understood what was required to prove a statement thoroughly. In part (ii) many did not appear to understand that only one counter-example is required to prove that a statement is not true.
For part (i) a sizeable minority simply tried to prove the statement using 5 values, stating that if it was true for all 5values, it must be true all of time. Many however worked with the given inequality and proceeded to $\left(x-5\right)^2$, but most could not fully explain that square numbers would

always be $\geqslant 0$, and even more rarely stated a suitable conclusion. The best solutions started with the statement $(x-5)^2 \geqslant 0$
In part (ii) most candidates understood the principle of finding a counter-example, although many found far more than necessary. There were frequent arithmetical errors, either in working out the value of $2^n + 1$, or in stating that numbers such as 9 were prime. For example $2^4 + 1 = 9$ was common. Some candidates gave a list of values, but failed to indicate which of their numbers were not prime.

<u>Question 4 (Mean Mark 5.6 out of 7)</u>

Almost all candidates were able to gain marks in this question, particularly in part (a). Candidates confidently applied the binomial series and had no problems with binomial coefficients, which were usually found using the ${}^{n}\mathrm{C}_{r}$ formula though a minority simply quoted the 6th line of Pascal's triangle. Most made good use of brackets when writing the unsimplified expansion, and consequently went on to find the correct expression. A small minority of candidates unnecessarily removed a factor of 2^6 before expanding. Such attempts were generally less successful, with errors occurring either when removing 2 or when simplifying the final answer.

In part (b) the majority of candidates spotted the connection with part (a), simply writing down the expansion of the second bracket and replacing the – signs with + 's. Others opted to expand again. However, many candidates were able to demonstrate that the expression could be simplified to $a + bx^2$ and calculated the correct coefficients. Common errors included multiplying the two series instead of adding, or assuming that both expansions were identical. As stated in the preamble to this report a common failing in show that questions is the lack of evidence offered by some candidates. It was vital in part (b) to demonstrate that the term in x and the term in x^3 cancelled and therefore disappeared in the resulting sum.

<u>Question 5 (Mean Mark 5.4 out of 8)</u>

In general, most candidates were aware that part (a) required differentiation, although attempts at integration were also seen. Some mistakes in differentiation were made but almost all of these seemed to be slips rather than misconceptions about differentiation.
Most candidates then knew that $\frac{\mathrm{d}P}{\mathrm{d}x}$ should be set equal to zero to find the maximum profit. Many achieved $x^{0.5} = 8$ but a sizeable number then proceeded to $x = \sqrt{8}$. For those who did find the correct value of x, 64, many did not find a value for P or else stated that the maximum profit was £136, not £136 000. It is important that for questions set in a context that give their answers within that context.
In part (b), most candidates knew that they needed to differentiate again and find the sign of the answer. Most attempted this by calculating the value of the second derivative at their x value. Many candidates lost the final accuracy mark. Common reasons include failing to correctly calculate and state the value of the second derivative, failing to give a reason (regarding the sign of the second derivative) or failing to give a conclusion.

<u>Question 6 (Mean Mark 6.4 out of 8)</u>

The factor theorem was familiar to most of the candidates and many were successful in using it correctly. Where marks were lost, it tended to be because insufficient working was recorded in order to 'show that' $k = 9$ as required by the question. Sometimes this was a lack of intermediate working, but more often it was the absence of '= 0' when setting f(3) = 0 and proceeding to find the value of k.

In part (b), most were able to factorise or use long division to divide by $(x-3)$ and most of these obtained the correct quadratic factor. However, a considerable number then struggled to factorise it further, with some candidates resorting to using their calculators to find the roots and then trying to work backwards. This often led to factors of $\left(x+\frac{2}{3}\right)$ and candidates did not usually adjust this to achieve the correct factorisation. A few candidates ended up with only one linear factor of the quadratic leaving a final answer of $(x-3)\left(x+\frac{2}{3}\right)$ or $(x-3)(3x+2)$.

Part (c) of this question caused problems for some, with the connection between it and part (b) eluding them. Some started again from scratch, some successful, some not; either way, a lot of time was needlessly expended. The more able very quickly used part (b) to obtain $\cos\theta = 3$ and $-\frac{2}{3}$, discarded $\cos\theta = 3$ and proceeded to find a value or values for θ. Very few candidates used radians in this question.

Question 7 (Mean Mark 5.3 out of 9)

Methods used to answer this question were generally well formed but a significant number of candidates lost marks due to a lack of accuracy in their calculations. Some candidates were confused about when to use a geometric series or an arithmetic series and attempted (a) and (b) with incorrect processes. Strangely for such a question, part (b) was attempted more successfully with part (a) less so. In part (c) a significant number of candidates failed to recognise that the sum of series was required or used a rounded value of r leading to inaccuracy.
In part (a) many candidates recognised it as an AP but the formula for the n^{th} term was often incorrectly stated as 16200 + 10d = 31500. This usually led to the incorrect answer of £17 730.
In part (b) the majority of the candidates were able to score two out of the three marks. The value of r was calculated correctly and applied well to find the second term. Most of the candidates lost the accuracy mark from using 1.08. A significant number of candidates did not recognise this as a GP and tried to work unsuccessfully with an percentage increase.
Fully correct answers in part (c) were rare. Where candidates applied the correct method throughout, the last mark was often lost due to use of rounded value of 'r' from (b). There were numerous cases where 11 was used as the value for n instead of the correct value of 10. It was pleasing to note however that 17% of the candidates achieved full marks on this question.

Question 8 (Mean Mark 4.8 out of 9)

Throughout this question many candidates work was difficult to follow because there were some very poorly written logs. It was often hard to distinguish the base, the number and the power.
In part (i) a great many partial attempts were seen. Most candidates took logs and used the power laws correctly with many attempting to use logs to base 2. Many, however, failed to deal with the log6 so could not reach the required form of answer.
Some candidates worked on the indices before taking logs, some producing elegant solutions with little need to manipulate logs – e.g. those who reached $2^{6x+2} = 3$ could complete the solution very easily. A most common mark in this part was 1 out of 4

Part (ii) was a more familiar question on this topic. Most candidates used the laws of logs very efficiently here, often producing a correct quadratic equation in y. The most frequent error was failing to consider whether both solutions of the quadratic were valid in the context of an equation in logs; many candidates lost the final mark because one of their solutions would involve taking logs of a negative number.

Question 9 (Mean Mark 5.2 out of 8)

Not all candidates attempted this question, but those who did mostly tackled it well.

Part (a) was highly discriminating and many candidates chose to just miss it out. Candidates who were familiar with the trig identities usually reached the required result. Some notational errors of $\cos\theta^2$ instead of $\cos^2\theta$ were seen.
In part (b) many candidates could apply the result from part (a) and solve the resulting quadratic in cos2*x*. Many changed variables in order to solve the equation, some forgetting to complete their solution by returning to the original variable. A few candidates forgot to divide their angle by 2, and it was common to see solutions outside the range, suggesting that some were not quite sure how big $\frac{\pi}{2}$ was.

Question 10 (Mean Mark 7.2 out of 11)
The last question on the paper also proved to be discriminating, especially parts (a) and (c).

In part (a) a sizeable minority of candidates saw the diagram and assumed that integration was required. Some attempted this via trail and improvement. Good candidates realised that the derivative was required and were able to differentiate successfully. Most of these then went on to compare it with zero. However, only a minority of candidates gave the exact range, with most preferring to give an approximation.

Part (b) was generally very well answered with many candidates scoring full marks. A significant minority of candidates are confused with integral notation, most evident when including the integral sign after integrating, so that the integrated expression is written as the operand of an integral. Very few bracketing errors were seen.

In part (c) a minority of candidates spotted the link with the information provided, whilst others preferred to calculate each integral from scratch. A common error in part (i), having realised that the respective areas were equal, was to give the answer as -8. Almost all candidates who attempted part (c)(ii) opted to integrate the function and substitute 6 and 2 to create an equation in *k*. It was not unusual to see the *k* term dealt with incorrectly, either by neglecting to integrate it, or by increasing its power to give $\frac{1}{2}k^2$.

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