Examiners' Report
Principal Examiner Feedback

Summer 2022

Pearson Edexcel International Advanced Level
In Pure Mathematics P3 (WMA13) Paper 01

This paper proved to be a good test of candidates' ability on the WMA13 content, and it was pleasing to see many candidates scoring a pleasing number of marks. Overall, marks were available to candidates of all abilities and the parts which proved to be most challenging were 5c, 6d, 8a and 9b.

There were a number of parts which stated that either relying on or entirely relying on the use of calculator technology was not allowed so attention should be paid to this information at the top of relevant questions. The information on the front of the paper does instruct candidates to make their method clear for all questions and so candidates should make sure that they do not resort to using a general equation solver (rather than typically accepting use of the quadratic solver) on their calculators as this may not necessarily score full marks.

There did not appear to be any evidence that candidates were short of time on this paper, although a large number did find the second part of question 9 very demanding and was not attempted in a noticeable number of cases.

Question 1

This question was generally well done. With many achieving full marks.

Part (a) was answered successfully by most of the candidates. Most used the chain rule to arrive at the correct answer, although a few integrated (and raised the power) rather than differentiating. However, most had the correct form, if not the correct coefficient. Only a few multiplied out brackets, but any seen typically ended up with mistakes in coefficients.

In part (b), the majority found the correct gradient and substituted $x=\frac{1}{3}$ to get -18. Most were able to find the negative reciprocal, however some proceeded with the same gradient of "−18" and could not score any further method marks. Some left the gradient in terms of x leading to working out which resulted in more challenging manipulation, and some incorrectly set $\frac{\mathrm{d}y}{\mathrm{d}x}=0$ to find x and used that as gradient. Many left their equation in fraction form rather than integer coefficients so lost the final A mark. A few did have the incorrect sign for $\frac{\mathrm{d}y}{\mathrm{d}x}$ and found gradient to be 18 so followed through to an incorrect gradient of the normal of $-\frac{1}{18}$ giving c as 55.

Question 2

Part (a) of this question was a straightforward substitution with most candidates choosing to substitute 5 into g first and then use their result to substitute into f correctly. A few arithmetic slips were seen but a conceptual misunderstanding of the correct order of operations was very rare. There were a few candidates who attempted to find the composite function algebraically first before substituting in; where candidates did this some did not then achieve the correct result due to a sign or arithmetic error, scoring only the M mark for the part. A small number of candidates thought they were multiplying f and g together and these candidates did not achieve any marks for this part of the question.
Part (b) was a routine question; candidates had been well drilled to swap over the x and y and rearrange to make y the subject of the equation. Generally, the algebra was well executed with few errors being seen. A

few candidates used poor notation such as $y =$ instead of f^{-1} which was penalised here for the A mark. Despite being a standard question, the majority of candidates still failed to state the domain for their inverse function and did not achieve the B mark. A small number of candidates had difficulty understanding the notation and either differentiated or found the reciprocal of f; these candidates were unable to score any marks for the part.

The majority of candidates who set up the equation correctly in part (c) went on to gain full marks displaying good algebraic skills. The main hurdle was simplifying the algebra correctly into a 3TQ and those unable to do this could only gain the B mark. There were a small number of candidates who wrote the final answer in decimal form, and this was penalised for the final accuracy mark. Those who failed to gain any marks in this part typically set $\mathrm{f}\left(\frac{1}{a}\right)=\mathrm{g}\left(\frac{1}{a}\right)$ or $\mathrm{f}(a)=\mathrm{g}(a)$, or used the reciprocal for f in setting up their equation. There was also a minority who created a cubic equation and came up with an additional answer of $a = 0$, if this answer was not rejected the final A mark could not be scored.

Question 3

This was a good question for many candidates with nearly all attempting and most proceeding with a correct method to find a value for *k*. The discrimination between the candidates was as a result of those who successfully applied the reverse chain rule when integrating.

In part (a), a majority of the candidates successfully integrated, although one mark was often lost either for forgetting the constant or having an incorrect multiple in front of the natural logarithm. There were a number of candidates, however, who integrated to achieve expressions which were not *A*ln(….) with some interesting rational expressions with polynomials on the numerator and denominator.

In part (b), a majority of candidates substituted the 5 and 2 into their expression to score the first M mark and many also successfully used the subtraction law for logarithms. Some candidates failed to deal with the $\frac{3}{2}$ or scored no further marks because their $\frac{3}{2}$ was, in effect, 1. A number of candidates tried to cancel the logs before combining into a single log and some tried to do $8^{\frac{3}{2}}$.

Question 4

In part (a) a common mistake was to state their equation of the line using a general form, which was not specific to the question. There were also many cases where *x* and *y* were used instead of $\log_{10} N$ and *t*. A vast majority achieved the mark for calculating the gradient which was often found in part (b).

Part (b) was generally well answered with a large majority of candidates scoring all three marks. However, there were some candidates who tried to combine the values for *a* and *b* within the equation $N = ab^t$ or made errors with trying to solve a pair of simultaneous equations.

Part (c) also had a high success rate. More candidates used the exponential form of the equation than those who used the linear form obtained in parts (a) and/or (b). There were a number of candidates who appeared to just use their equation solver in part (c) and should be reminded to make their method clear. There were also candidates leaving their answer as a logarithm which given the nature of a model, candidates should use the advice regarding rounding their answer to the required level of accuracy rather than trying to give an exact answer.

Question 5

This question provided a good level of discrimination across the three parts. Candidates typically had greater success with the earlier parts with part (c) only being successfully answered by the most able candidates

Nearly all candidates gained the first two marks in part (a) of this question. A very small number made arithmetic or sign errors for a(ii) but on the whole a very well answered part.

Part (b) was again a routine part of a candidate's knowledge, and they generally completed this part of the question well, achieving both critical values and correctly identifying the range. Others rearranged their equations to the form $k = ...$ instead of $x = \cdots$ so they had incorrect critical values. Some candidates only solved one side of the modulus function and these candidates did not gain any marks for the part. A minority of candidates made arithmetical slips with one correct critical value identified scoring only the M mark in this part. There were occasional notation errors in identifying the correct range of values for the final A mark but generally very well answered.

Part (c) provided the most challenge in the question and was one of the most difficult parts of the whole paper. The majority of candidates did not employ a correct strategy to tackle this part, and many left it blank. Where candidates spotted that they needed a line ($y = 3-2x$) that passed through the point $\left(\frac{9}{k}, -2\right)$ this approach proved successful and efficient in calculating the value of *k*; a few candidates then failed to consider the range of values and were unable to obtain the final A mark. The most popular approach was to find the point of intersection with the lines $y = 3-2x$ and $y = 7-kx$, and then $y = 3-2x$ and $y = kx-11$. Candidates then arrived at two equations in terms of *k* and *x*, but many failed to solve them simultaneously to find a value for *k* gaining no marks in this part. There were other attempts to use the critical values in part (b) which was an incorrect approach.

Question 6

This was a good question to test differentiation with power of a half. Parts (a) to (c) were generally well answered. The candidates who struggled with this question were either unable to use the product or quotient rule correctly or did not know how to differentiate. Some who got the differentiation correct were unable to express the differential over a common denominator.

In part (a) the product rule was well understood with most candidates achieving the first two marks, although whilst most found the correct form, not all were able to find the correct coefficients, and some lost the *x* in 10*x*. Some struggled to achieve a common denominator and therefore only scored half marks for part (a). There were a few cases of manipulating the answer to get the required one so careful attention was needed when looking through their working.

In (b) and (c), there were few cases of incorrect working/answers. Candidates usually found the roots and correctly selected the negative answer. It was acceptable to use the quadratic solver for this part as it was only worth one mark, so the method did not need to be seen. Some candidates struggled with the evaluation when $x = -2$ however.

Part (d) was rarely answered correctly. Many found one limit (usually the lower bound) but not both. $-56 \leqslant g(x) \leqslant 4$ was common. Many scored the B mark for −30 or it was often implied by sight of -56. It was also common for the answer to be given with incorrect inequality signs, too.

Question 7

Despite being a question later on in the paper this question was attempted by the majority of candidates. Whilst part (a) was challenging, many were able to make good progress in part (b).

Part (a) was not accessible to candidates who had a poor knowledge of trigonometric identities. Some candidates expanded out the brackets and changed everything to sin and cos but made no real progress in achieving the required form. Many candidates made several attempts at the part with a large amount of crossing out seen with some eventually proceeding to a correct solution. Candidates who began by dividing by the $2\sin\theta$ were usually able to achieve the required form successfully and more efficiently than those who expanded the brackets first. Substituting $\cot^2\theta = \text{cosec}^2\theta - 1$ was also efficient and resulted in less sign and arithmetic errors than routes involving sin and cos. Candidates should continue to be reminded to show all stages of their working as some progressed without showing key steps such as sight of $\sin 2\theta$ or $...\sin\theta\cos\theta$ which resulted in the last mark being lost.

Part (b) was usually always attempted, whether or not they attempted part (a). A minority did not solve the quadratic equation correctly and gained no marks for this part, but most made a good attempt recognising the need to use the reciprocal in calculating the sine of the angle and going on to find a correct angle. It was disappointing that many candidates failed to identify the second solution here to gain the full marks. Where candidates had found the two answers some did not achieve the final mark, losing accuracy on the smaller angle. A minority worked in degrees only and also lost the final A mark. Some candidates got confused with the roots found and thought they had found the roots for $\text{cosec}^2\theta$ or even if they had found the reciprocal, they did not find arcsin of the reciprocal (instead finding sine of the reciprocal).

Question 8

In part (a) a large number of candidates understood that they had to solve $\frac{dy}{dx} = 0$ and often they differentiated correctly. Consequently, most scored the first two marks. Following the right set up of the equation, some struggled with solving it. A common mistake was failing to handle $\ln 9e^{-0.75t}$ correctly. Expressions like $-0.75t\ln 9e$ were often seen. It was noticeable how often candidates successfully found a value for *t* and then failed to go on to find a value for *v*. It was clear that a lot of candidates used their calculator to solve the exponential equation when they encountered difficulties with the manipulation. Whilst it was not penalised on this occasion, candidates should expect to show sufficient method as to how to deal with exponentials and logs before progressing to more trivial linear equations where it might be more appropriate to make use of calculator technology. In such cases where not a complete method is clear, it may be that full marks will not be awarded in the future, despite a correct answer. In the case of this part it was a requirement to see calculus so candidates who did not show this and just achieved the correct answer scored 0 marks.

Part (b) was well attempted, although a few candidates failed to integrate the 12. Substituting the limits was done well but some candidates assumed the lower limit as automatically 0. Some stopped at this stage and failed to attempt to make T or $12T$ the subject. There were often mistakes in copying and negative signs missed off the powers, so the A mark was lost. Others did not equate to 100, but still just progressed to writing the given answer without considering whether they had actually completed the question correctly.

There was a good success rate in part (c) and most candidates identified correctly what was needed. Quite often, those who could not access parts (a) and (b) did score all three marks in part (c), although careful attention should be paid to the level of accuracy required. In addition, as this equation could be solved directly on a calculator, it is even more important that candidates show the method of embedding the values in the iterative formula to demonstrate they understand how to generate the values. This was an example of an answer not implying a correct method to solving had been shown.

Question 9

The final question presented significant challenge to some candidates, as was evident from the number of blank responses. It was particularly good for discriminating between candidates at A and A*. It was accessible to the more able candidates and scoring full marks was not uncommon.

Those who did attempt (a) mostly differentiated correctly using the quotient rule and were able to reach the correct equation. The mark scheme was helpful in saying that we did not need to explicitly see the 'squared' identity stated or substituted in as otherwise many candidates would have lost marks otherwise. Due to the difficulties in determining whether the quotient rule had been applied the correct way round or a sign error, some candidates may have been fortuitous here in not being penalised for the method.

Part (b) was similar to a question which appeared on the sample assessment material and provided candidates with an opportunity to solve the problem in a variety of different ways. This resulted in lots of scribbling, crossings out, lines of algebra leading to nowhere and largely irrelevant formulae at the side of the page. Most who were successful used $R\sin(x+\alpha)$, correctly getting values for R and α and using the correct steps to find a value for x. Those who opted for the squaring methods, the one which proved most successful was dividing by $\cos x$, leading to $4\tan x = 3$. Very few candidates who solved using squaring methods checked their solutions, and the consequence was that even among those who correctly processed the equation many found additional incorrect values. This suggested they had not read the question as rather than just solving a trigonometric equation they should have been finding a coordinate. In addition, an inspection of the graph would show that the x coordinate was positive so candidates who found an angle which was negative should have appreciated that the one found was not the one required. Many lost the final mark as the exact value is very close to 3.785, and candidates needed to exercise great care to avoid premature rounding, as this could easily result in a value that rounded down to 3.78. There was also a number of candidates who squared each individual term or used incorrect identities.