Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2022

Pearson Edexcel International Advanced Level
In Pure Mathematics P2 (WMA12) Paper 01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

October 2022
Publications Code WMA12_01_ER_2210

General

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. The questions that proved to be the most challenging were 3(b), 5(b) and question 10. It was clear that many candidates did not appreciate the demand in question 1 and performance here was extremely variable.

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 a given answer such as in 4(a) where there was a requirement for candidates to show how to get from $a^{10} = 2$ to $a = \ldots$ in order to access the final mark. Some candidates also showed an over-reliance on verifying a given result rather than formally "showing" it. This was seen in 2(a) and 8(a). Such approaches are sometimes given credit in the mark scheme provided a suitable conclusion is provided but this was often not the case.

Report on individual questions

Question 1

The opening question on proof by exhaustion was poorly answered on the whole. Many students appeared to be unfamiliar with the concept and there were a significant number of blank responses.

Most were able to produce one correct combination but not all who used the given equations were able to do this – sometimes the result of using $c = b - 2$ instead of $c = b + 2$. Those who did attempt to list the other combinations often failed to consider that a, b and c were defined as positive integers. It was surprising to see that the definition of "product" is not widely understood, with many students considering the sum of a, b and c instead. Those who had achieved the correct three rows and products often failed to make any conclusion. There were a significant number of attempts seen using logical or algebraic approaches. Such attempts were mixed in quality and often unnecessarily long-winded. Algebraic attempts often had errors. Some who obtained a cubic expression for the product just concluded it was even without any justification.

Question 2

In part (a), most understood the remainder theorem and were able to replace x with $\frac{5}{4}$ but a regular failing was not demonstrating sufficient working. $\frac{4}{5}$ was substituted erroneously on occasion. Weaker attempts included trying to expand the bracket via various means or attempting a long division. A relatively small number attempted to verify that k was $\frac{2}{5}$ and as is often the case with this approach, a conclusion was required but rarely provided.

Generally good scoring was seen with the binomial expansion in part (b) although a wide range of errors were made. The most common were sign slips, often from working with powers of $+\frac{2}{5}x$ instead of $-\frac{2}{5}x$. A small number of students unfortunately altered a correct expansion–usually by multiplying through by 5 to remove the fraction. Most expansions used $(a + b)^n$ although there were a few attempts to extract the "2". A few weak attempts to manually multiply out were seen.

Part (c) was reasonably well-answered although some differentiated the original expression instead of using the answer to (b). Those who did differentiate their expansion usually scored both marks. The most common error was to substitute $x = 0$ into $\mathrm{f}(x)$.

Question 3

There seemed quite a significant number of candidates who were confused by this question leaving it blank or nearly blank, likely due to not understanding how to deal with the square of the trigonometric ratio. Part (a) was largely accessible as long as students remembered to work in radians which unfortunately far too many did not, gaining no marks. It would be recommended that centres check students understanding of notation; degrees symbol being necessary for work required in degrees and arguments in terms of pi implying radians. Another common error in (a) was misunderstanding the requirement of "exact values" resulting in not evaluating the terms and giving trigonometric expressions.

Part (b) was less accessible than (a) likely due to the lack of familiarity. Furthermore, it was evident that candidates who were working in degrees were much less likely to even attempt it. That said, a pleasing number recognised the need to break the summation into two separate sums, acknowledged the sum of the first 50 natural numbers was required and worked this out correctly. A common error was then to assume the trigonometric sum was $\left(\frac{1}{4}+\frac{1}{4}+1\right)\times\frac{50}{3}$ rather than considering the period of the series. Other common errors were taking $\sum n$ to mean $1+1+1+\ldots=50$ and largely not considering the two sums separately but instead trying to incorrectly calculate the sum of an 'arithmetic' or even on the odd occasion a 'geometric' series. Full marks were quite rare although there were some elegant and succinct fully correct solutions, with the most common correct method for the periodic summation being $16\times\left(\frac{1}{4}+\frac{1}{4}+1\right)+\frac{1}{4}+\frac{1}{4}$.

Question 4

This question was very accessible to students with the majority achieving full or nearly full marks. A small minority of candidates were not able to apply the subtraction law for logs successfully which generally lost them most of the marks.

In part (a) many candidates were able to make a start by substituting in the given values and correctly applying the subtraction law for logs to achieve the correct log equation and then correctly removing the log. Some then lost the final mark by not showing sufficient method in their final step of finding the 10^{th} root of 2 or a more accurate value for a. It is highly recommended that students are familiar with the rigour needed for 'show that' questions.

In part (b), many candidates were able to score the first mark for correctly using the subtraction law (this was the most common approach) or for rearranging the equation. Most of these candidates attempted to remove the log and make t the subject. The most common mistakes seen were expanding log $(t + 5)$ as log t + log 5 and incorrectly simplifying $4(1.072w)$ to $4.288w$. Of those who used the alternative approach in the mark scheme, most used an approximated numerical value for log 1.0724 in their answer and so were unable to gain the final mark.

Part (c) gave all candidates, regardless of logarithmic knowledge, a chance to gain a mark with nearly all candidates achieving at least the method mark for substituting $w = 15$ and proceeding to reach a value of t. The very large majority of candidates achieving full marks in (b) were able to get full marks in part (c). Those that didn't generally used an accurate version for 'a' rather than 1.072 as instructed, meaning they lost the accuracy mark. Some candidates used the original equation and were generally successful though they did create extra work for themselves. That said, those who did not achieve full marks in (b) were advantaged by using this method.

Question 5
This question on a trigonometric equation was a good source of marks in part (a) but progress in part (b) was very mixed.

The two identities needed in part (a) were widely recalled although $cos^2\theta$ was occasionally replaced with $1-sin\theta$). There were a few cases of poor algebraic processing such as $3(1-sin^2\theta)$ expanded to $3-sin^2\theta$. Persistent notational slips such as missing arguments caused a few students to have the final mark withheld.

Part (b) is a common type of question on this paper, yet the response was rather varied. A small number of students did not use the result in part (a) and unnecessarily attempted a restart. Some used an incorrect equation they had produced in part (a). Many did achieve the correct roots, mostly by calculator, although a small number thought the equation could be factorised. A lot of confusion with variables ensued and mislabelled roots invariably led to no further marks. The negative root was occasionally rejected. The subsequent operations required were often either not carried out or executed in the wrong order. Arcsin was not always used or followed halving of the values. Many students did not attempt to look for additional solutions–very few sketched helpful graphs or CAST diagrams. Work was sometimes seen in degrees. Premature rounding was widespread and the last mark in this question was one of the most rarely scored of the entire paper.

Question 6
The full three marks were widely scored by most in part (a) although the usual errors were seen. The value for *h* was occasionally incorrect – sometimes the result of relying on the formula booklet and confusing the number of strips with the number of ordinates. Errors with brackets cost many and there were also some incorrect values that followed a correct numerical expression, including answers given to three significant figures rather than the required three decimal places.

Although there were many fully correct answers in part (b), this part produced a fairly mixed response on the whole. Almost all attempted to integrate the given curve equation and the correct value for the area under C_2 was widely achieved. A few attempts involved trying to use the trapezium rule again. There was considerable confusion about how to use this value and the answer to part (a) to find the shaded area. Many thought the "6" had to be involved at this point and they often then found the unshaded area. Some identified the correct area but did not convert this to a percentage or converted it incorrectly. Premature rounding or giving the final answer to the nearest whole number rather than to three significant figures cost some the last mark.

Question 7
Part (a) was very well answered and almost all candidates were able to obtain at least the first mark for expanding at least 2 terms correctly. A small minority multiplied the numerator by 21 instead of dividing. One error seen a few times was to give the last term as $-10^{\frac{1}{2}}$ omitting the "x". Occasionally the "x" disappeared on other terms as well, and usually these candidates did not continue to part (b). Some candidates failed to simplify the first term's coefficient $\frac{12}{21}$ to $\frac{4}{7}$ and $\frac{182}{21}$ was sometimes not correctly simplified to $\frac{26}{3}$. There were a few sign errors on various terms as well, where "$+$" became "$-$" for no apparent reason.

In part (b), there were some instances where candidates were unable to achieve marks due to their simplified polynomial not having the correct indices, often due to the $-10\sqrt{x}$ term. In general, if a candidate attempted this part by differentiating their answer to part (a), they did so correctly and went on to score full marks, with the exception of the few who did not set their derivative equal to zero before the final conclusion. One common error seen here was to differentiate $2x^3 - 10x^2 + 13x - 5$ to obtain $6x^2 - 20x + 13$ and set this equal to zero, which some then went on to solve, which implied a misinterpretation of the question.

In part (c), many candidates who failed to make progress in part (b) were still able to gain all 3 marks here by finding the exact x coordinates of the two other turning points. A small number of candidates tried to obtain a quadratic by writing $x(2x^2 - 10x + 13) = 5$ showing no appreciation of the factor theorem. Those who achieved all 3 marks mostly used the long division method to find the correct quadratic factor. A minority of candidates relied on calculator technology and only stated decimal approximations of the *x* coordinates of the other turning points and so achieved no marks in this part.

Question 8
This question was well answered by the majority of candidates. In part (a), many candidates scored full marks for a correct proof, satisfactorily eliminating the a from $3a = \frac{a}{1-r}$. Almost all candidates started with the correct formula for the sum to infinity equated to 3a, but some candidates did not immediately recognise how the *a*'s cancelled or made algebraic errors and did not show that $r = \frac{2}{3}$. There were a few cases where the accuracy mark was not awarded due to sign errors in the working. Only a minimum of one intermediate line of working was required to be seen here, but a few candidates did not provide this and so lost both marks. A small minority of candidates opted for the alternative by verification approach. Of those who did try verification by substitution of $r = \frac{2}{3}$, some of these did find their sum was equal to 3*a* but failed to state any conclusion, losing the accuracy mark as in question 2(a).

In part (b) many candidates were able to achieve the value of the first term by a correct method, with some interesting approaches such as:

$$u_2 - u_4 = 16 \Rightarrow u_2 - r^2u_2 = 16 \Rightarrow (1 - r^2)u_2 = 16 \Rightarrow u_2 = \frac{16}{1 - r^2} \Rightarrow u_2 = 28.8 \Rightarrow a = \frac{28.8}{r} = 43.2$$

Others found the value of u_4 first and then divided repeatedly by *r* to find the first term.

There were cases where candidates incorrectly used $ar + ar^3 = 16$ or $ar^2 - ar^4 = 16$ or $ar^3 - ar = 16$. Another error seen repeatedly was the use of a^3r instead of ar^3. A small number of candidates used the sum formula before a value for the first term had been found and these were rarely successful.

In the final part of this question some candidates confused the formulae for the term and the sum and incorrectly used ar^{n-1}. Of the majority who did use the sum formula, some mistakenly substituted in *r* to the power of 9 rather than 10. A small number of candidates lost the final accuracy mark due to insufficient accuracy of their answer.

Question 9
This question was generally well attempted with few non attempts or zero scores overall and with many candidates going on to score the majority of the marks.

In part (a), the majority of students achieved full marks. A few students differentiated correctly, found the correct roots but then only substituted $\frac{1}{3}$ into the original equation, thus losing the accuracy mark for this part and subsequent parts, while others differentiated a second time and attempted to solve this equation, and so did not score the first method mark. A large number of students found the second derivative unnecessarily to check which was the minimum turning point, which could have been done by inspection. Sometimes this is what led to them using $\frac{1}{3}$ as they confused the conditions for second derivative giving maxima or minima. Some candidates did not complete the differentiation and instead chose to solve the cubic, which resulted in no marks being scored.

Part (b) was very well answered. Candidates generally found the correct y coordinate of A, and knew to use the distance formula with their A and T. They also knew to substitute into a circle equation. There were occasional errors when writing down the equation of the circle such as $(x-5)^2+(y-3)^2=10$ or $(x-3)^2+(y-5)^2=\sqrt{10}$.

There were a few non attempts at part (c). Most of the correct attempts used the gradient formula correctly to get -3 and proceeded correctly to get full marks. A few found the equation of the required line and the equation of the line through T parallel to the required line and solved simultaneously to find the gradient -3 and proceeded correctly. A small number used the implicit differentiation method to find the gradient. Having found the gradient, it was rare to see errors in deriving the equation correctly. However, a common problem was that many candidates did not show sufficient working to find the initial gradient and could not be deemed to have shown the given equation as a result. It was clear that some candidates had identified that the required gradient was $\frac{1}{3}$ and had worked backwards to find the gradient of AT as -3. Without any evidence of where the -3 had come from in the first place, the maximum mark that could be scored was 010.

Most candidates attempted part (d) but did not always complete it correctly. Most either subtracted the line from the curve and then integrated, or integrated separately and then subtracted. Mainly, this was done correctly but there were a few with incorrect limits or careless errors in their integration. The main scheme method of subtracting the area of the trapezium was also seen frequently, often with the correct outcome, but the most common error was to fail to subtract the area of the trapezium. At the end of a long question, it is strongly advised to 'go back' and check that the required area is being found. A small number of candidates failed to show any integration and so lost the marks due to the demands of the question.

Question 10

Many students found this question challenging. There were quite a few non attempts or zero scores with little to mark. $\log_2 9 = 3.16$ was seen in a significant proportion of scripts. It was generally followed by an abandonment of the question. This could be contributed to a failure to read the "Given ..." statement at the start of the question.

In part (i), part (a) was quite often correct, although answers of 3, $3a$, and a^2 were frequently seen, with the latter the most common. Those who attempted part (b) usually scored the method mark but frequently did not simplify $\log_2 16$.

A large number of candidates either missed out part (ii) or their attempt was a guess which achieved no marks. Many only got the B mark, most commonly for some work involving the power law. A common misconception was to take logs of both sides but then multiply on the LHS instead of using the addition rule, which resulted in scoring a maximum of the B mark only. Those who used the addition rule correctly very often went on to complete successfully. Completion of the question was sometimes found difficult as students struggled to use the information given in the question. Hence students achieved $\frac{\log_2 \frac{3}{8}}{\log_2 6}$ leading to $\frac{(\log_2 3 - \log_2 8)}{\log_2 6}$ but then failed to expand further to get $\frac{\log_2 3 - \log_2 8}{\log_2 3 + \log_2 2}$.

Poor notation for logs was reasonably common, with log being used in place of . It was not uncommon to see candidates using a different base (often 6 or 10) and failing to convert back to base 2).
The majority of students used the approach in the main scheme, but all of the other methods were seen, with a few others that merged the methods in the mark scheme. The alternative method not requiring logs was seen frequently and usually with a successful outcome. Those who used change of base also seemed confident with their method.

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom