Pearson

Examiners' Report
October 2025

International Advance Level in Pure Mathematics P4

WMA14/ 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 learners at: www.pearson.com/uk

October 2025
Question Paper Log Number P78851A
Publication Code WMA14_01_2510_ER
All the material in this publication is copyright
© Pearson Education Ltd

General Comments

This paper provided a variety of challenge and discrimination across the questions covering the specification for this unit, and it was pleasing to see learners were able to make attempts at all the questions. There were some questions which learners found particularly challenging which were appropriately found towards the end of the paper, namely Questions 8, 9 and 10. Question 3 also proved to be a challenge, however, it was often just the marks for the domain and range which were not gained, possibly due to ensuring they had fully answered all parts of the question.

Question 1

This question on the binomial expansion should have been a familiar type of opening question. It was answered well by the majority of learners; however, a significant number scored very few marks.

In part (a), most learners were able to take out a common factor of $\frac{1}{4}$ and attempted the binomial expansion with a power of -2. A common error was to have an incorrect coefficient of *x* by either losing the 2 in the denominator or having *x* rather than $\frac{5}{2}x$. Some did not multiply the expansion by $\frac{1}{4}$ preventing scoring of two marks. A small number used direct expansion with limited success.

In part (b), stronger responses showed the correct range of values for *x* but there was a significant number of responses that did not. Some had $x < \frac{5}{2}$ instead of the correct $|x| < \frac{2}{5}$ or $-\frac{2}{5} < x < \frac{2}{5}$. Part (b) was generally not very well answered, with many learners not showing that they were able to use the expression $|x| < 1$ to

manipulate $\left|\frac{5}{2}x\right|<1$ into $|x|<\frac{2}{5}$. Incorrect answers included $x<-\frac{2}{5}$, $|x|<\frac{5}{2}$, $|x|>\frac{2}{5}$ and $|x|<1$

Part (c) involved following through on the quadratic expression from part (a) and required all 3 terms to be multiplied by 16. The most common error was to times by 4 instead. Stronger responses picked up this mark even if they errors were present in part (a), but a large number of learners did not score.

Question 2

This question using integration was generally answered well with almost all learners knowing how to find a volume of revolution about the *x*-axis and many being able to integrate $\left(\frac{5}{3}\sqrt{x-1}\right)^2$, substitute limits correctly and reach the correct answer in the required form. Learners who used the volume formula correctly were usually able to correctly integrate the function ....$(x-1)$ reaching the required form Bx^2-Cx. Mostly learners used $\int(x-1)\mathrm{d}x=\frac{x^2}{2}-x$ rather than $\int(x-1)\mathrm{d}x=\frac{(x-1)^2}{2}$. A few learners missed the π in the volume formula which prevented them from scoring 2 marks. However, condoning missing the $\mathrm{d}x$ and allowing for the π to be implied by later work allowed for most learners, who put the π in their final answer, to pick up full marks. There were comparatively few errors, and it was very rare for learners to make no attempt at this question.

The majority of learners did not show the substitution of the limits 8 and 2 separately and wrote $\frac{25\pi}{9}\left[\frac{x^2}{2}-x\right]_2^8=\frac{25\pi}{9}(24-0)=\frac{200\pi}{9}$. The main reason for scoring no marks was due to not squaring *y* in the formula but this was not common. Where errors were seen, they included:

- not squaring the constant $\frac{5}{3}$,
- multiplying the integral by 2π instead of π,
- omitting π,
- making sign errors when substituting the limits such as e.g. $\frac{8^2}{2}-8-\frac{2^2}{2}-2$
- giving the final answer as a decimal instead of exact.

Question 3

Learners were challenged by this question using parametric equations with it being rare for full marks to be seen; a significant number did not to score any marks.

In part (a), most learners were able to make *t* the subject in one of the equations and many continued to replace *t* in the second equation thus achieving a Cartesian equation. Manipulation to the required form was less successful. Even more rare was giving the domain of *x* correctly either in an inequality or stating the values of *e* and *f* as required.

Part (b) was also found to be challenging by the majority, with many leaving this part out completely.

A small number gave both ends of the range but many only had the upper limit correct. Occasionally learners did find the correct limits but then did not give the range in an appropriate form, with some using *x* instead of *y* or g(*x*).

Question 4

Overall, this question using implicit differentiation was quite well answered with many learners able to pick up most of the marks and most learners were able to make some progress. There were very few non-attempts.

In part (a), most learners realised that they needed to use implicit differentiation and were able to reach the correct forms required. There were quite a few sign errors when attempting to differentiate the $2xy$ term, however. Quite a significant number of learners then realised they needed to collect their terms in $\frac{\mathrm{d}y}{\mathrm{d}x}$ and proceed to $\frac{\mathrm{d}y}{\mathrm{d}x} = \ldots$. A large number of learners reached $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{24 - 8x + 2y}{2y - 2x}$ but then did not simplify so did not gain the final mark in this part. There were a significant number of learners who seemed to know that implicit differentiation was required but did not reach the required forms. There were a small number who tried to rearrange the given equation to $y = \ldots$ and then attempted to differentiate but often with little success.

In part (b), most learners who had attempted part (a) set their $\frac{\mathrm{d}y}{\mathrm{d}x} = 2$ and found a linear equation in *x* and *y*. There were some learner who had attempted to find $\frac{\mathrm{d}y}{\mathrm{d}x}$ but the error made meant that they would not reach a linear equation so they did not score any marks. There were quite a few learners who did not proceed from this point with a variety of incorrect approaches seen such as trying to find a value for *x* or *y*. Of the learners who did proceed, most were able to reach a quadratic equation which they then solved and found coordinates for *P*. There were some errors at this stage or learners who had made errors earlier on in their working so whilst they did not reach a correct quadratic, they were still able to solve and find coordinates. Most learners worked in x and y throughout but there were some who worked in terms of a and b. Most attempts at solving the quadratic seemed to be via a calculator.

Question 5

This question testing understanding of three-dimensional vectors demonstrated that learners either fully grasp this topic or find it challenging such that typically they scored either full marks or no marks.

In part (i), those who recognised that they needed to equate coordinates usually went on to score full marks. Common errors included adding vectors, equating vectors to zero, adding the x, y and z coordinates all indicating limited understanding of this topic. Some had the correct method but made arithmetical errors when finding the values of μ, λ and hence β.

In part (ii), learners attempted to find the coordinates of P using their value of λ or the values of μ and β. This was usually done well. However, a significant number did not proceed on this part. Some learners opted to try to find the coordinates of P using two different approaches thinking that there was more than one possible set of coordinates for P, when it was arithmetical errors resulting in the discrepancy.

Question 6

Many learners had a good overall idea on how to carry out integration by substitution with many strong responses showing the correct substitution and then integrating correctly using appropriate limits. However, many learners made errors in their manipulation which resulted in expressions which they did not integrate.

It was not uncommon for learners to have 3 as the upper limit of the integral, or to switch the limits around successfully to deal with the negative expression. However, there were a few instances of the misplacement of the limits. Some learners did successfully attempt integrating using the substitution and then revert back to the trigonometric function and using the original limits. The learners who made some progress on this question had common errors which often

included missing the negative sign so not achieving the first mark or getting this correct but then losing the minus sign in their workings. Others placed their limits incorrectly, whilst others, having achieved suitable substitution, did not integrate their function or did not split up the two terms correctly. It was not uncommon for the first mark for differentiating the substitution to be the only mark gained on this question. Substituting into the given function to find an integral in terms of '*u*' seemed challenging for quite a few learners. It appeared that knowledge of the double angle formulae was also limited. If this was known, then learners often did not replace $\cos\theta$ in terms of '*u*'. The occasional learner did not use the substitution given and tried to use $u^2 = 3 + \cos\theta$. There were quite a few non-responses seen on this question.

Question 7

This second question on vectors demonstrated a general reliance on calculators which meant that many learners were unable to score full marks.

In part (a), most learners applied the scalar product formula between $\overrightarrow{BA}$ and $\overrightarrow{BC}$, with many arriving at a correct equation of $\cos\theta = \frac{9\sqrt{2}}{14}$ or $\cos\theta = \frac{9}{7\sqrt{2}}$. A common error was applying the scalar product formula between $\overrightarrow{AB}$ and $\overrightarrow{BC}$, which resulted in $\cos\theta = -\frac{9\sqrt{2}}{14}$, although some learners incorrectly dropped the negative sign. Another frequent error was not giving the answer in its simplest form. A few learners arrived at the correct answer by applying the cosine rule.

Many learners found part (b) challenging, with many not finding the exact value of $\sin\theta$. Most learners found an approximation for the angle θ and applied the formula $ab\sin C$, for example $7 \times 5\sqrt{2} \times \sin\left(24.6^\circ\right) = 20.6.$ A minority of learners used $\sqrt{1-\cos^2\theta}$ or constructed a right-angled triangle to find the exact value of $\sin\theta$. Those learners who wrote the area expression

$7\times5\sqrt{2}\times\sin\left(24.6^\circ\right)$ or $7\times5\sqrt{2}\times\sin\left(\cos^{-1}\left(\frac{9\sqrt{2}}{14}\right)\right)$ only gained the second method mark for applying the correct area formula. Only a few learners received full credit by simplifying this expression to give the correct $5\sqrt{17}$. Learners should be reminded to read the warning over calculator use and the need to show all stages of working. Given that the form of the answer was given and was irrational, it was important that learners maintained accuracy in their solution to score full marks.

Question 8

This question tested understanding of solving a differential equation using integration by parts. Learners generally knew what to do, but the execution and reliance on learning rules resulted in many not scoring full marks.

In part (a), there were a few learners who were able to have success and understood how to integrate by parts twice. They showed clear understanding and were able to substitute in the values to find the integrating constant. The errors that were made with this part usually involved an incorrect sign; often losing a negative sign in one of the terms. Also, the '12' was taken out and then omitted in later work.

There were a few learners who realised that they needed integration by parts but chose to integrate 12t instead of differentiating and could not progress. A common error was not integrating e^{-t} correctly either making a sign error or changing the index. There were a number of learners who wrote the exponential term as e^{-1} and treated it as a constant. When substituting in the values to find the integrating constant, there was often a numerical error. There were a number of learners who forgot the + c and did not progress any further once they had integrated. There were many learners who either did not attempt this question or did not integrate the function. Indeed, there were a number of responses who

attempted the "DI" method, but whilst they had created the typical table that is often seen, they infrequently progressed from there.

Part (b) was a good discriminator between learners to test understanding. If the learner had a correct answer for part (a) they were often able to realise that '18' was the maximum value and answered this successfully. There were a couple who tried to solve the equation and used this to support their explanation. However, more often than not, this was part was omitted, particularly if part (a) had been challenging.

Question 9

This question provided a good opportunity for learners to demonstrate their understanding of parametric equations and key integration techniques. The structure of the question was designed so that learners who did not complete part (a) could still make meaningful progress in the later parts. However, the length of the question and the limited understanding of this topic meant that full marks were not obtained often and in a notable number of cases, learners either abandoned the question, or did not attempt it at all.

In part (a), most learners recognised the need to differentiate the two parametric equations and began the question confidently. Differentiation of $x = \mathrm{f}(t)$ was usually correct, but the differentiation of $y = \mathrm{f}(t)$ appeared to cause difficulty for some, with several learners incorrectly integrating to obtain a natural logarithmic expression. There was widespread understanding that $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\mathrm{d}y}{\mathrm{d}t} \div \frac{\mathrm{d}x}{\mathrm{d}t}$, and many learners used this approach successfully, although a significant proportion multiplied by the reciprocal rather than dividing directly. Both methods were usually valid, but inaccuracies sometimes occurred. A common error was omitting the factor of 2 in the denominator, leading to an incomplete derivative. Learners who obtained a correct expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$ generally proceeded well,

setting the derivative equal to -4 and forming the resulting quadratic equation in *y*. Solving the quadratic equation was usually handled well, and many learners then found the required value of *y*. A common misunderstanding was to also calculate *x*, indicating a lack of attention to the specific requirement of the question. A small number of learners used values of *t* outside the stated interval, demonstrating that they had not fully engaged with the constraints given. Some learners attempted to convert the parametric form into a Cartesian equation. This approach was rarely successful; learners commonly applied either the chain rule or quotient rule incorrectly on the resulting function of *x*. On rare occasions, a correct Cartesian form of *x* in terms of *y* was found and working with $\frac{\mathrm{d}x}{\mathrm{d}y}$ allowed progress, but this was uncommon.

The responses to part (b)(i) were mixed. Most learners scored the initial mark for identifying the correct limits of integration, although a significant minority incorrectly used the values of *t* taken directly from the graph rather than converting to values of *x*. Forming the integrand was the most common point of error. Learners who had correctly determined $\frac{\mathrm{d}x}{\mathrm{d}t}$ in part (a) typically understood how to manipulate d*x* into a form suitable for substitution. The most frequent incorrect response was an integrand with a numerator of 1, caused by not applying the chain rule correctly when differentiating the logarithmic expression in part (a). These learners consequently could not access the later marks.

Those who reached part (b)(ii) with a correct expression from part (b)(i) generally produced well-constructed and often nearly fully correct solutions. Using partial fractions was the expected method, and most learners who identified this made sound progress. However, some attempted unsuitable strategies involving the natural logarithm of the entire denominator, which did not lead to valid routes to the answer. Errors were common in setting up the partial fractions, particularly in handling the factor $2t+3$. Learners who successfully decomposed the expression usually earned all method marks, although errors during integration

sometimes prevented the final accuracy mark. A notable minority produced equivalent forms using denominators such as $3t+3$ or $6t+15$; these were acceptable when used consistently and correctly. When substituting the limits, most learners who had correct working reached the correct final value. A recurrent error was mishandling the factor of 2 inside the logarithm; some learners incorrectly square-rooted the term, others simply did not apply the power law, preventing attainment of the final mark.

Question 10

This last question was the most challenging question on the paper. As is often the case for questions on proof by contradiction, there were a notable number of blank scripts, although this appeared to be less commonly seen than the previous sessions. Also, there were very few completely correct solutions in this question as responses often did not set the contradiction up correctly or because the statement(s) were proved using numerical values, only to give examples which shows the statement(s) were true.

Part (a) was accessible for learners by having a partially completed attempt at showing that if x^2 is odd, then x is odd. The majority of learners stated that $x^2=(2m)^2=4m^2$ and gained the first mark but some learners did not start with $x^2=\ldots$ and did not score as they had not correctly linked what they were asked to show. Most learners did not gain the second mark as they did not write a correct explanation and conclusion. Those who gained this mark mostly rewrote the given statement rather than specifically stating contradiction hence proven.

In part (b), many learners started with the correct assumption and wrote $a^2-4b=27$ but were unable to deduce in the anticipated approach that if $a^2=4b+27$ then a^2 is odd, so scored no marks. A few learners recognised that if $a^2=4b+27$ then a^2 is odd therefore *a* is odd and wrote $a=2k+1$ getting

$(2k+1)^2 = 4b+27$ and rearranged to $b = \ldots$ to show that *b* cannot be an integer. Most of these learners did not complete the proof, however, as they were unable to write a correct statement showing that there is a contradiction with a conclusion. A few learners stated that a^2 is odd and *b* is even, so $a = 2k+1$ and $b = 2k$, then substituted these values in the given equation and tried to solve for *k*, reaching $k = \frac{13}{2}$, which is not an integer. Some learners started with $a^2 - 4b = 27$, so $a = \sqrt{4b+27}$, and concluded that *a* is not an integer. A few learners used odd/even integers in their proof, but most of these did not complete their proof fully as they checked only one case without explanation why the other was not necessarily required.