Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2025

Pearson Edexcel International Advanced Level
In Pure Mathematics P4 (WMA14) Paper 01A

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General Comments

This paper proved to be a good test of candidates' ability on the WMA14 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. There appeared to be less of an over-reliance on calculators and where the warnings in the question were to 'show all stages of your working' and 'not to rely on calculator technology' these were generally followed.

There were some instances where marks were lost unnecessarily by a large number of candidates and should be borne in mind for future series. 2 particular examples are:

- answers should be given in the form requested e.g. in question 7(c) as $p + \ln q$ and not e.g. $A + B\ln C$
- appropriate notation should be used when dealing with vectors e.g. not writing a vector as $\begin{pmatrix} \mathbf{i} \\ 5\mathbf{j} \\ -11\mathbf{k} \end{pmatrix}$ and giving the vector equation of a line l as "$\mathbf{r} =$" not "$l =$"

Question 1

This question proved to be a challenging start to the paper for many students who were not familiar with integrating log functions. The majority correctly attempted to use integration by parts but about a third tried to use $u = 2x$ and so made no progress and gained no marks. Of those who correctly used $u = \ln(3x)$ it was very common to see $\frac{\mathrm{d}u}{\mathrm{d}x} = \frac{1}{3x}$ which lost the two accuracy marks. Very few students used a substitution before integrating by parts but those who did tended to be successful. Of those who integrated correctly, it was quite common to see errors after substituting the limits while attempting to combine 9ln9 and −ln3 to arrive at the correct log term of 17ln3, as well as occasional sign slips.

Question 2

This question was generally found to be very accessible by candidates. Most candidates approached this problem with a correct understanding of volume and surface area relationships, and many demonstrated sound calculus skills. The question was one of the best answered in the paper, with many candidates scoring full marks.

In part (a), most candidates were able to correctly identify the volume of a cube as $V = x^3$ and proceeded to obtain $\frac{dV}{dx} = 3x^2$. Those who then wrote down the correct chain rule usually substituted correctly to obtain the correct final answer. The most common error observed was the incorrect application of the chain rule. Some candidates who correctly obtained $\frac{dV}{dx} = 3x^2$ simply multiplied this by 5 without a clear understanding of the chain rule's application in related rates. Some candidates were also confused between volume are area and incorrectly thought that $V = 6x^2$, losing marks here and in part (b). There were some more unusual approaches seen in part (a) involving differential equations and implicit differentiation. Candidates who dealt with the problem this way were usually successful.

Part (b) required candidates to find the value of x from the volume provided and use this to find the value of $\frac{dx}{dt}$ from the expression obtained in part (a). The majority of candidates who were successful in part (a) carried forward their work correctly. Errors seen in this part included finding x by squaring the cube's volume instead of cube rooting it and using x^2 in the numerator rather than the denominator when they were careless in their presentation of the answer to part (a).

Question 3

There were a few candidates who simply did not understand how to solve equations such as this and scored no marks for this question, however the majority of candidates separated the variables correctly and got the first B mark but often got no further marks. Some candidates separated the variables but failed to include any integration signs and lost this B mark by not attempting any integration. Of those who separated the variables correctly and attempted integration, a very large number of candidates failed to recognise that the integration of the function in y required a reversal of the chain rule or could done using a suitable substitution. Invariably this meant that candidates could not progress further than the first B mark as the second method mark for finding the constant of integration was dependent on the first method mark. Many candidates tried to use integration by parts in a variety of ways but this did not usually get them anywhere. However, those that differentiated e^{y^2} as part of their workings generally then recognised the integral and managed to produce the correct integration. They usually then went on to score the rest of the marks for this question. Marks were sometimes lost by forgetting to include a constant of integration and so they could not access the last two marks. Candidates should think about why $x = 0$ and $y = 5$ were given in the question and how they might be used. Marks were also lost by poor manipulation of logarithms as some candidates tried to log each part separately to remove the exponential before they found the constant of integration and so lost the last A mark. The final mark was also sometimes lost for lack of brackets, for multiplying by 4 rather than dividing by 4 and for writing the final answer as $y^2 = \mathrm{e}^{\frac{x^2}{8}-\frac{17}{8}}$ rather than $y^2 = \ln\left(\frac{x^2}{8}-\frac{17}{8}\right)$.

Question 4

This question tested candidates' understanding of the binomial expansion for fractional powers and their ability to apply this to related expressions and approximations. Performance on this question varied widely. Strong candidates demonstrated clear algebraic reasoning and careful simplification. However, some responses showed gaps in applying the expansion correctly, especially with handling constants and interpreting the validity range.

In part (a), most candidates recognised that the expression needed to be rewritten into a form suitable for binomial expansion. Many correctly factored out the constant term 4, but a number of candidates forgot to take its square root or omitted it completely in the final answer. The coefficients in the expansion of $\left(1+\frac{5x}{4}\right)^{\frac{1}{2}}$ were handled with ease but problems sometimes arose when squaring or cubing the $\frac{5x}{4}$. The power would sometimes be placed inside the brackets and miscopies of values occurred. Sign errors and missing brackets also appeared in several responses when simplifying the expansion.

In part (b), although worth only one mark and not affecting the rest of the question, this part was frequently answered incorrectly. Many candidates correctly spotted $\left|\frac{5x}{4}\right| < 1$ but some made errors rearranging it or there were slips with the 5 so candidates obtained $|x| < 4$ or even $|x| < \frac{1}{5}$. Others omitted the absolute value or gave only one side of the inequality (e.g., stating that x is less than a certain value but not greater than the corresponding negative). These errors suggest that the conditions for the validity of binomial expansions are not yet fully secure for some candidates.

In part (c)(i) most candidates understood that substituting a negative x would change the signs of the odd powered terms. However, a number of responses incorrectly changed the sign of the squared term or reversed the signs of all terms, regardless of power. These sign errors were among the most common mistakes in this part and often led to the loss of follow through marks. Several candidates restarted the expansion, rather than replacing x by negative x in their answer to part (a). In either case, odd powers of x generally became negative.

Part (c)(ii) was generally well attempted by those with a correct or mostly correct expansion earlier. Most candidates realised that adding the two expansions would cancel the odd powered terms, leaving only the constant and the squared term. Errors here usually stemmed from incorrect signs.

Question 5

Most candidates attempted this question, but few scored full marks. In part (a), the majority of candidates could differentiate $4y^2$ with respect to x correctly but marks lost were due to incorrect differentiation of the e^{xy} term and this proved to be the most challenging part for candidates in this question. A small proportion of candidates were able to differentiate this accurately. However, some candidates mistakenly wrote e^{xy} as $e^x \times e^y$ and then used the product rule.

In part (b) candidates usually attempted to make $\frac{\mathrm{d}y}{\mathrm{d}x}$ the subject first and then substituted to find the numerical value for the gradient of the tangent. Although there were errors in their derivative, most candidates only had two $\frac{\mathrm{d}y}{\mathrm{d}x}$ terms and thus were able to gain the method marks for using their derivative and finding a numerical value for the gradient of the tangent. They often then used this correctly to find the equation of the tangent. There were quite a few examples where candidates, who had an expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$, just wrote down a value that did not correspond to the use of $x = \frac{9}{2}$ and $y = 0$. In such cases the method mark for substitution could not be awarded by implication and this meant the subsequent method mark was also forfeited. Candidates are advised to show the substitution in such cases or at least check that their evaluation is correct for their expression.

Question 6

This question was generally well attempted; most candidates were familiar with the method of using parametric differentiation to find the equation of the tangent or normal to a curve.

In part (a), the vast majority of candidates were able to correctly differentiate the parametric equations and proceeded to achieve the correct gradient. The most common error was to confuse $\frac{\mathrm{d}x}{\mathrm{d}t}$ and $\frac{\mathrm{d}y}{\mathrm{d}t}$ ending up with the wrong gradient. There were some attempts to use a Cartesian approach but these could gain no credit because of the demand to use parametric differentiation.

In part (b), almost all students correctly found the gradient of the normal and most used a correct method to find the coordinates of P. Some though, incorrectly solved $y = 0$ to find t and usually gained no further marks. There were a few sign or rearrangement errors when finding the x-coordinate of R but a large number of students were successful in this part.

In part (c), there were a few candidates who struggled to understand what was required. Candidates often made no attempt at all or attempted to find the equation of a straight line. Some could at least score the first mark by writing $\sin t$ in terms of x or $\cos t$ in terms of y. Of those who knew what was required here, many thought that they were required to find a Cartesian equation in the form $y = \mathrm{f}(x)$ and spent a lot of time unnecessarily rearranging the equation after they had already achieved a required form. The most common form given was $y^2 = 6\sqrt{1-\left(\frac{x-2}{8}\right)^2} - 3$ rather than the expected $\frac{(x-2)^2}{64} + \frac{(y+3)^2}{36} = 1$ and many went further unnecessarily by expanding the bracket to give a simplified quadratic as the numerator under the square root.

Question 7

Question 7 proved to be a good discriminator, effectively distinguishing between candidates with a solid understanding of differential equations and those with more superficial knowledge. This question assessed multiple integration techniques within a single structured problem, requiring clear algebraic manipulation and a sound understanding of substitution and partial fractions. While many candidates demonstrated foundational knowledge and approached the question with confidence, others struggled, particularly with the algebra and simplification required in parts (b) and (c). Marks were lost due to minor slips rather than a complete lack of understanding.

In part (a), candidates were required to apply a substitution to simplify a given integral. Most recognised the need to find $\frac{\mathrm{d}u}{\mathrm{d}x}$, substitute both the expression and the limits and correctly derive the new integrand. The majority were able to substitute and rearrange to the required form, while some took very long-winded ways to get to the given answer. The majority of candidates achieved a correct equation when differentiating the substitution, most commonly $\frac{\mathrm{d}u}{\mathrm{d}x} = \mathrm{e}^x$. Re-arrangements of this were often less successful. The most successful method was using the direct replacement of e^x with $u + \frac{1}{2}$. Some common errors seen were

- failing to change the limits of integration
- incorrect or incomplete algebraic simplification of the new integrand, often omitting to change dx to in terms of du
- incorrect replacement of dx

- incorrect expansion of $(2u)^2$

Also, many candidates showed minimal work, therefore not showing enough steps to receive full marks for this part of the question. Candidates are reminded to show all working to obtain full marks in a "show that" question.

Candidates familiar with the technique generally performed well in part (b) although many candidates did not finish the solution, omitting to write out the coefficients with their partial fractions but often managed to recover this in part (c). Common mistakes in this part included

- arithmetic errors when solving for constants A and B
- obtaining incorrect expressions when multiplying up
- values for the constants obtained correctly but then interchanged when substituting into the given expression

Many candidates made mistakes in their working that caused them to get the wrong answer for A, B or C and sometimes all three. This could have been easily corrected/avoided had they checked their work.

In part (c) candidates were asked to integrate the partial fractions and express the final answer in logarithmic form. Successful responses followed through logically and were simplified using correct log work. A common error was to not give the answer in the form required e.g. as $\frac{4}{3}+2\ln\left(\frac{9}{8}\right)$ rather than $\frac{4}{3}+\ln\left(\frac{81}{64}\right)$. Surprisingly, most mistakes did not come from the integration but from their manipulation when substituting their limits. A lack of a strong understanding of log rules contributed to this. When integration mistakes were made, it was usually integrating $\frac{4}{2u+1}$ to $4\ln(2u+1)$. Occasionally, candidates tried to integrate $\frac{5}{u^2}$ to a logarithmic form.

Question 8

This was an accessible vector question with the majority of candidates successfully scoring the first 2 marks in part (a)(i) and there were very few instances of addition, incorrect subtraction or subtracting the wrong way round, however there were a few instances of poor vector notation. If column vectors are used then the **i**, **j**, **k** are not required and candidates lost the first accuracy mark unless correct notation was seen first. So $\mathbf{i} + 5\mathbf{j} - 11\mathbf{k}$ and $\begin{pmatrix} 1 \\ 5 \\ -11 \end{pmatrix}$ are correct notation but $\begin{pmatrix} \mathbf{i} \\ 5\mathbf{j} \\ -11\mathbf{k} \end{pmatrix}$ is not. Part (a)(ii) was often correctly done with candidates understanding the form of an equation of a straight line but as in previous series, many candidates lost this mark for not giving the line in the form "**r** =". The most common incorrect notation was to state "l =" and many also had nothing in front of their "equation" and lost this mark.

Part (b) was also well attempted with many candidates correctly finding vector *CA* working out $\mathbf{a} - \mathbf{c}$ and similarly vector *CB* usually as column vectors and then applying the scalar product and setting it = 0. Those who did that and did not score full marks in this section had generally made errors in finding either vector *CA* or vector *CB* with transposition errors and sign errors impacting accuracy. A frequent algebraic mistake came in handling the **k** component of the vector. This manifested itself as $5\mathbf{k} - (-\mathbf{k}) = 5 + \mathbf{k}$ or as $\mathbf{k} - 6\mathbf{k} = \mathbf{k} - 6$ leading to a scalar product in 2 variables p and k. This was usually avoided by those using column vectors. A few candidates tried to add the vectors and this scored no marks as the subsequent method marks were dependent. There were a few candidates who set the scalar product equal to -1 and seemed to be trying to use the perpendicular gradient rule. Other candidates just set $(2 - p)(3 - p) = 0$ and forgot about the **j** and **k** terms and so scored no further marks in this part of the question. Many candidates successfully reached the three-term quadratic equation and solved it correctly, often using a calculator. Candidates are advised to gather the quadratic equation into the correct form of $ax^2 + bx + c = 0$ before solving to try and eliminate any errors when putting the values into their calculator.

Part (c) was the least successfully answered part of the question. Candidates generally used their positive value for p and substituted into their vector *CA* or vector *CB*. Unfortunately, errors in their original expressions for these vectors, compounded by use of an incorrect value of p, meant that some candidates could not access the accuracy marks here. Candidates often unnecessarily found the angle between *AB* and *BC* or between *AB* and *AC* using the scalar product, thus wasting a lot of time. They did not seem to realise the angle between *AC* and *BC* was 90° even though they were told this for part (b) so they could just find the lengths of *AC* and *BC* and then proceed to find the area directly. Often, when they did use this longer method, mistakes were made and thus, they lost the final accuracy mark. A diagram can often help and in this case would have been useful to show that C was a right-angle and then $\frac{1}{2}\text{base} \times \text{height}$ could have been used. The final mark was also lost with candidates leaving their answer as a surd rather than to 3sf which was required in the question. A few candidates worked out the areas for both values of p and also lost the final mark.

Question 9

Part (a) was an accessible opening to this question as almost all candidates knew how to find volume of revolution about the x-axis thus gaining the first mark in this part. Some candidates were then able to recognise the method of integration and integrate the function accurately. The most common reasons for loss of marks in this part were where candidates forgot to square the 12 or did not recognise the method of integration.

Part (b) proved to be very discriminating, with relatively few able to adopt an appropriate strategy for finding the value of a. The most common incorrect strategy was to apply the limits 0 and a to their integration from part (a), set this equal to 360π and solve for a. Of those who made any progress, the vast majority applied the limits a and 20 to their integration from part (a), set this equal to 360π and solved for a. Whilst this could lead to the correct answer, most candidates did not realise that the actual value of a would be found by subtracting their value from 20. There were many candidates who failed to tackle this part of the question as they did not see the link to part (a). Relatively few candidates (8.4%) managed to score full marks on this question.

Question 10

This question tested candidates' understanding of proof by contradiction, specifically using properties of even and odd integers and logical reasoning involving algebraic expressions. It was one of the more challenging questions on the paper, and not many candidates answered it correctly. A significant number failed to structure their proof clearly or misunderstood what was being asked. A common and serious misunderstanding was to treat the additional note — stating that if the square of an integer is even, then the integer itself is even — as the statement to be proven. Some candidates either attempted to prove this assumption or combined it with the correct contradiction statement. As a result, they lost focus on the actual aim of the question. Among those who approached the question correctly, many began by assuming that the expression equals zero and rearranged the equation logically. These candidates often reached the conclusion that p^2 is even, then deduced that p must also be even, making appropriate use of the assumption provided in the question. It was rare for students to not get at least a mark for the assumption or for the first step in their working out. Though it was also rare to see full marks as many students couldn't create robust arguments and conclusions. Relatively few candidates successfully carried the argument through to a fully argued contradiction. Some omitted key steps, used incorrect algebra or gave vague conclusions without a clearly stated contradiction.

Common incorrect strategies and reasons for losing marks included

- treating the bracketed italic statement as the statement to prove
- failing to clearly state the assumption for the contradiction or mixing it with other incorrect or irrelevant statements
- concluding p is even but not using this to reach a contradiction
- substituting $p = 2k$ but failing to explain that the resulting expression leads to a non-integer value for q
- setting $p = 2k$ and $q = 2k$ and then rearranging to a quadratic in k
- algebraic manipulation errors when rearranging, leading to work which did not establish a required contradiction

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