Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

January 2022

Pearson Edexcel International A Level
In Pure Mathematics (WMA14/01)

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General

This paper gave students plenty of opportunity to demonstrate what they had learnt. The work was often well presented and fully correct solutions to all questions were seen. It seems that candidates are becoming more confident with "proof" questions such as question 6, although a significant number of candidates did not attempt this question or just made a contradictory statement and made no further progress.

Questions 7 and 9 proved to be the most discriminatory and provided a suitable challenge for the more able candidates.

Report on individual questions

Question 1

The first requirement of this question, to find $\frac{\mathrm{d}y}{\mathrm{d}x}$, was very well answered with the majority of candidates getting a completely correct derivative. A few stumbled in using the product rule but most scored the first mark for an implicit differentiation attempt. Just a few candidates failed to differentiate the constant 6. Rearrangement to make $\frac{\mathrm{d}y}{\mathrm{d}x}$ the subject occasionally caused problems but was generally completed competently.

Most candidates also did well in finding the equation of the tangent, though the final mark was occasionally lost due to a sign error or not giving the final equation in the required form. Just a few found the equation of the normal rather than the tangent.

Question 2

Part (a) was well attempted and there were very few who did not get full marks. Only a small minority failed to use a fully correct binomial structure, although a few used $4x$ instead of $4x^3$ in their expansion. Some continued (unnecessarily) to find the fourth term. Part (b), however, proved to be more of a challenge. There were some fully correct answers but some candidates only scored the first mark for substituting 1/3 into their answer for (a). Some gave their answer as a decimal instead of the required fraction, perhaps not understanding the term 'rational' and it was clear that a few had simply resorted to using their calculator to find the cube root.

Question 3

Part (a) was a fairly familiar question which required the candidates to form a Cartesian equation from parametric equations for x and y. A good proportion of the candidates earned five out of the possible six marks and almost all were able to attempt a solution.

The vast majority of candidates used the double angle formula for $\cos 2t$, replacing it with $1 - 2\sin^2 t$. They rearranged the equation for x to make $\sin t$ the subject and substituted this into the denominator of y.

There were slightly different ways of rearranging: some making $\cos 2t$ the subject first; others rearranged both parametric equations to get expressions for $\sin t$ and $\sin^2 t$ in terms of x and y, for example. In the vast majority of cases, the method chosen was successful. However, those candidates who tried to make t the subject, i.e., $t = \sin^{-1}(0.5 \times -1.5)$ and substituted for t into $\cos 2t$ in the denominator of y were unable to progress.

A much smaller number of candidates, having used the double angle formula as above, factorised the denominator directly as the difference of two squares before substituting $x - 3$ for $\sin t$.

Very few candidates chose to start with the given Cartesian equation, replacing x with $3 + 2\sin t$ and then using a double angle formula to replace $\sin^2 t$ with $\frac{1-\cos 2t}{2}$ leading to the given equation for y.

A few used $\sin^2 t + \cos^2 t = 1$ as a starting point and with care were able to substitute both x and y, leading to $\frac{3}{y} - 3 + \frac{(x-3)^2}{4} = 1$ which they could re-arrange to achieve the required equation.

A significant number of candidates lost the final accuracy mark in this part due to having made sign errors sometimes in the expansion of $(x - 3)^2$ but more often in simplifying the denominator as some had difficulties dealing with the $\frac{(x-3)^2}{2}$ in the denominator of the fraction.

Having reached the given expression for y in terms of x, many candidates omitted finding the values of p and q to define the domain. They may have forgotten about it rather than not knowing how to do it. Where an attempt was seen, it was often correct.

In part (b), candidates were required to find the partial fractions for the expression given in part (a) and then to make a slight adjustment to reach the required form. Many candidates earned all three marks for this part, but it was more common for candidates to score two marks out of three. The vast majority of candidates knew how to find the partial fractions of a straightforward expression with two single linear factors in the denominator. Many did not realise that their answer including a denominator of $(7 - x)$ was not yet in the required form. Others did notice that $(7 - x)$ in the denominator did not match the required form but incorrectly changed only their denominator making their answer incorrect. A few candidates noticed the changed denominator but then chose to find partial fractions for $\frac{12}{(x+1)(x-7)}$ which was not what was asked for – these candidates were not given any marks in this part, while the candidates who correctly adjusted the fraction to $\frac{-12}{(x+1)(x-7)}$ usually gained full marks.

A large number of candidates were unsure as to how to present the final fractions due to the numerator not being a whole number. Any of the following solutions was acceptable: $\frac{\frac{3}{2}}{(x+1)} - \frac{\frac{3}{2}}{(x-7)}$ or $\frac{3}{2(x+1)} - \frac{3}{2(x-7)}$ or $\frac{1.5}{(x+1)} - \frac{1.5}{(x-7)}$. A large number chose to avoid the issue by stating the values of a, b, c and d. A small minority of candidate worked correctly until the final step and then just changed the denominator of $(7-x)$ to $(x+7)$.

Question 4

Most candidates scored well on this question, with a substantial number getting full marks. It appeared that there was generally a good understanding of methods for dealing with connected rates of change.

In part (a) some lost marks because they did not give enough evidence to prove the given answer. Others seemed to be confused and did not seem to understand what was required. Most, however, were able to find the area of one of the triangular faces, either by using the formula $\frac{1}{2}ab\sin C$ or by finding the height of the triangle and using $\frac{1}{2}bh$.

In part (b) nearly all knew they had to use the chain rule and did so correctly, although it was disappointing to see many instances of poor notation for the required derivatives. There were a few calculations slips which forfeited the last mark.

Even those who failed to score marks in part (b) were sometimes successful in (c), though the final mark was occasionally lost due to rounding.

Question 5

This question on integration of parametric equations was generally well attempted.

In part (a), the majority of students were able to find $\frac{\mathrm{d}x}{\mathrm{d}t}$ and substitute into the formula, combining the two square roots to achieve the correct form (and consequently gaining the first 3 marks). Very few dealt with the limits correctly, with most having 0 as the lower limit and as a result they did not see the need to change the order of the limits. This led to a very common $K = -2$ and lost the final mark.

There was a small proportion of students who did not get the correct form for the first method mark in part (a) – usually these candidates achieved something of the form $(\ldots)^{\frac{3}{2}}$ and were only able to score a maximum of 1.

In part (b), many candidates were only able to gain the first two marks. Nearly all candidates were able to gain the B mark for a correct equation connecting $\mathrm{d}u$ with $\mathrm{d}t$. Many candidates were able to substitute into the integrand, but a significant proportion were unable to obtain an integral just in u. Those students that were able to substitute and achieve an expression of the correct form usually went on to integrate correctly but many had problems when it came to applying limits. The common errors were to either apply limits for t ($\frac{9}{4}$ and 0) to u or vice versa, or to apply the limits in the wrong order – not understanding that because of the change of limits that 81 was now the lower limit.

A number of candidates completed the substitution correctly with the exception of having u in place of $\sqrt{u}$ in the denominator. Some of those getting as far as $\frac{8-u}{16\sqrt{u}}$ failed to split the fraction into two terms to arrive at an expression they could integrate.

There were some very good candidates who made light work of both parts in this question, producing concise and clear solutions with a thorough account of limits in part (a), which was pleasing. There were very few candidates who tried alternative approaches to the suggested substitution.

Question 6

This question was poorly understood by candidates, with many having little idea of how to construct a proof by contradiction. Many left it blank or managed only the first mark. A significant number failed to demonstrate the properties of a geometric sequence and tried to process an arithmetic series. There were a small number who tried to compare the ratios but did not proceed to an equation in k. If the correct quadratic equation was established full marks were usually achieved, the most common method being to find the discriminant and state it was less than zero, hence no real roots. It was common, however, to see statements without proof such as "$(1 + 2k)^2$ does not equal $k(3 + k)$", with no further progress. The final mark was sometimes lost due to the omission of an appropriate concluding statement. A few candidates simply attempted to substitute values for k and were unable to make any progress.

Question 7

Part (a) was tackled very well with most candidates obtaining full marks. Solutions were generally well-presented with accurate, complete notation used. This contrasted with some sloppy presentation and omissions in other calculus work from the same candidates in part (b). When candidates failed to score all three marks, it was as a result of either multiplying out $\frac{1}{4}(4-x)$ or replacing it by -$\frac{1}{4}(x-4)$ before squaring with resulting errors. Some candidates made the question harder than necessary and expanded to include the e^x before squaring, which led to more frequent errors. The coefficient of $\frac{1}{16}$ in the e^{2x} term caused problems for a significant proportion of candidates, with many incorrectly multiplying through by 16 instead of taking it out as a factor, and as a result lost the final mark.

In part (b), a significant number of candidates failed to recognise the need to use integration by parts and so failed to score any marks for this part. Candidates writing down expressions for u and v' and the resulting u' and v tended to fair better in producing correct results for the first application and similarly again for the second application. For others, presentation often became confused with many crossings out and a failure to either recognise or apply integration by parts a second time. The second application without the use of bracketing often resulted in a sign error with candidates effectively using $-(uv + \int u'vdx)$. Candidates using Way 3 from the scheme and subdividing their work into 3 separate integrals before bringing their work back together met with some success and were less prone to integration errors, but commonly sign errors occurred with this approach. In a small number of cases, integration by parts was attempted in the wrong direction, integrating the quadratic term and differentiating the e^{2x} term, including some candidates who had completed the first step correctly but changed direction for the second. Substitution of limits by candidates reaching that stage was usually sound though coefficient and/or sign errors meant they could not achieve the correct final answer.

Question 8

Many gained full marks on this question but a few seemed to have little idea of vector methods, gaining just one or two marks.

Part (a) was well attempted, although a few lost a mark by failing to express the equation of the line in the correct form **r** = … Apart from this, the most common mistake was to use the point *B* as the direction vector.

Part (b) was also generally well answered. Some errors were made in forming the equations for the components and a few candidates declared that the lines were parallel, but many scored all four marks by solving for μ and λ from two equations and establishing a contradiction in the third equation. Sometimes numerical errors led to the loss of the final mark.

In part (c) most candidates achieved the first mark but many had difficulty deciding which vectors to use for the dot product. A few failed to convert their obtuse angle to the required acute angle, losing the final mark. There were, however, some good, accurate solutions to this part.

Question 9

This question was probably the most discriminating and least accessible question on the paper. There was a reasonable proportion of candidates who made no attempt or scored no marks.

Candidates who attempted part (a) usually applied the chain rule, although the quotient rule was occasionally seen. The most common errors when applying the chain rule were to overlook the '2' when differentiating $2\ln y$, giving a final answer of $-\frac{2}{y}(1+2\ln y)^{-3}$ or subtracted from the power incorrectly, resulting in $-\frac{4}{y}(1+2\ln y)^{-1}$. A few candidates, perhaps not understanding that they were differentiating with respect to y, included a factor of $\frac{\mathrm{d}y}{\mathrm{d}x}$ ($\mathrm{d}y$ was also seen).

Many candidates made some attempt at (b) and successfully separated the variables. Some did not recognise that the integral with respect to y related to (a) and consequently made an unsuccessful attempt at the integration. More success was seen with the integration with respect to x. The $\frac{1}{\operatorname{cosec} 2x}$ term was often successfully written as $\sin 2x$ and integrated to $-\cos 2x$ but, not infrequently, the $\frac{1}{3}$ became 3.

Candidates who had some form of answer to (b) generally achieved at least the first method mark in part (c) by substituting the initial conditions into their equation to find their constant of integration. A good number of candidates managed to gain the second method mark by applying the double angle identity to $\cos 2x$ to get it in terms of $\cos^2 x$, and some automatically gained it through integration when making use of the $\sin 2x$ identity in part (b). In the vast majority of cases, if a candidate gained the first accuracy mark they went on to gain full marks in this part of the question. A small number of candidates substituted the initial conditions straight into the equation given to find the constant A, which gained no marks.

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