Examiners' Report
Principal Examiner Feedback

Summer 2025

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

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This WMA14_01 paper was an appropriate test of the specification. There were sufficient standard questions to satisfy the well- prepared with the necessary stretch and demand to test the higher achieving candidate. The paper was of appropriate length with little evidence of candidates rushing to complete the paper.

Question 1

Question 1 was based around work on implicit functions. Part (a) was almost always answered correctly. Candidates needed to take care in part (b) however as there were several areas in which they could drop marks. The majority of well-prepared candidates scored at least 4 of the 6 marks, with full marks common. Reasons why marks were lost in this question were;

- Failure to correctly differentiate $-6xy$ correctly with sign slips common.

  E.g. $-6xy \to -6x\frac{\mathrm{d}y}{\mathrm{d}x}+6y$
- Failure to correctly differentiate $7\mathrm{e}^{2x-1}$ correctly with $7(2x-1)\mathrm{e}^{2x-1}$ more common than expected
- Candidates finding the equation of the normal rather than the equation of the tangent

Question 2

Question 2 on related rates of change produced fewer full mark responses than expected. Many candidates scored 3 out of 4 marks with the final mark being lost due to the lack of a valid reason as to why their rate of change of r was inversely proportional to r^2. These candidates merely stopped when they achieved $\frac{\mathrm{d}r}{\mathrm{d}t}=\frac{k}{4\pi r^2}$ or else additionally stated hence proven without giving a reason. Examples of acceptable reasons and conclusions are;

- $\frac{\mathrm{d}r}{\mathrm{d}t}=-\frac{k}{4\pi r^2}=-\frac{c}{r^2}$, hence proven
- $\frac{\mathrm{d}r}{\mathrm{d}t}=\frac{k}{4\pi r^2}$. Since $\frac{k}{4\pi}$ is a constant $\frac{\mathrm{d}r}{\mathrm{d}t}\propto\frac{1}{r^2}$

Question 3

This question tested candidate's ability to solve a differential equation. There were two main routes through the problem with the majority of candidates opting to convert the expression $\frac{\sin 2x}{\cos^2 2x}$ to the form $\sec 2x \tan 2x$ which could then be integrated. The other option was to realise that the integral was of the form $(\cos 2x)^{-1}$. Candidates were successful via both routes with the majority of marks being dropped for the following;

- Integrating $3\sec 2x \tan 2x$ to $3\sec 2x$ rather than $\frac{3}{2}\sec 2x$
- Integrating y to y^2 rather than $\frac{y^2}{2}$
- Making numerical or algebraic slips, thus finding an incorrect value for c in the equation $y^2 = 3\sec 2x + c$

Question 4

Questions on partial fractions are usually well received by candidates and this was no exception.
Part (a) was straightforward with most candidates scoring all 3 marks. Errors were rare and usually involved an incorrect value for one of the constants.
Part (b) was more discriminating with plenty of room to make slips whilst integrating. Most candidates realised that the ln function was required along with the use of limits and ln laws to reach the form of the answer suggested in the question.
Common reasons for a loss of marks here were;

- Integrating $\frac{4}{(1-x)} \to 4\ln|1-x|$ not $-4\ln|1-x|$ as required
- Integrating $\frac{8}{(2x+1)} \to 8\ln|2x+1|$ not $4\ln|2x+1|$ as required

Question 5

Part (a) required candidates to use parametric differentiation to find the equation of the normal to the curve at the point $t = 2$. Whilst most understood that the value of $\frac{\mathrm{d}y}{\mathrm{d}x}$ was required, finding it caused many issues, not least the fact that the quotient rule was needed to find $\frac{\mathrm{d}x}{\mathrm{d}t}$. Errors and slips were plenty although careful and well-prepared candidates gave excellent responses. Common errors here were;

- Sign slips when simplifying $\frac{\mathrm{d}x}{\mathrm{d}t} = \frac{2(1-t)-(-1)(3+2t)}{(1-t)^2}$
- Algebraic errors in simplifying $\frac{\mathrm{d}y}{\mathrm{d}t} \div \frac{\mathrm{d}x}{\mathrm{d}t}$ leading to an incorrect expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$
- Failing to find the negative reciprocal of the gradient of the tangent when finding the equation of the normal

Full marks in part (b) were extremely rare but many scored 2 or 3 out of the 4 marks available. The most popular way of finding the cartesian equation was through finding t in terms of x using the equation $x = \frac{3+2t}{1-t}$. Substituting this into $y = 1 - t^2$ gave a form, which when simplified led to the equation $y = \frac{10x-5}{(x+2)^2}$. This is where the vast majority of students ended their answer, not realising that the domain of this function was required, that is $x \neq -2$.

Question 6

Whilst part (a) was a fairly standard question, a mark of 1 out of 2 was the most common. Candidates knew how to find the 'gradient' vector but many had an inappropriate term on the left- hand side of the equation, usually l = rather than $\mathbf{r}$ = .

Part (b) required some problem- solving skills and very few marks were available if vector $\overrightarrow{AC}$ was not found. Attempts should have used the fact that $\overrightarrow{AB} \bullet \overrightarrow{AC} = |\overrightarrow{AB}||\overrightarrow{AC}|\cos 45$. It is important to note that candidates should show their working in such calculations so that examiners can credit them for a correct method. This was rare, and this part of the examination contained more numerical and algebraic slips than any other part of the paper. An example of an intermediate line that shows a correct method would be $\cos 45° = \frac{2\times 4 + 8\times 4}{\sqrt{4^4+4^2}\times\sqrt{68+(\alpha-2)^2}}$

The major reasons for the loss of marks in Question 6 were;

- Writing the equation in part (a) as $l = \begin{pmatrix} 5 \\ 2 \\ 1 \end{pmatrix} + \lambda \begin{pmatrix} -4 \\ 0 \\ -4 \end{pmatrix}$ rather than $\mathbf{r} = \begin{pmatrix} 5 \\ 2 \\ 1 \end{pmatrix} + \lambda \begin{pmatrix} -4 \\ 0 \\ -4 \end{pmatrix}$
- Slips when finding one of the components of $\overrightarrow{AC} = 2\mathbf{i} + (\alpha - 2)\mathbf{j} + 8\mathbf{k}$
- Slips in finding $\left|\overrightarrow{AC}\right|$ with $\sqrt{2^2 + (\alpha - 2)^2 + 8^2}$ being incorrectly written as $\sqrt{\alpha^2 + 72}$ for example

Question 7

Par (a) was another proof. Candidates should be make all their steps clear and use correct notation. It was vital to see both $\frac{\mathrm{d}u}{\mathrm{d}x} = \sec^2 x$ and $\tan^2 x = \sec^2 x - 1$ used in converting $\int \frac{\tan x + \tan^3 x}{(4 + \sec^2 x)^3}\,\mathrm{d}x$ to an integral in terms of u. Most candidates who knew and used these facts, generally went on to score at least 3 of the 4 marks available, whilst those who did not, generally scored 0 marks.
Part (b) was equally discriminating. There weren't as many full mark responses as expected.
Common reasons for the loss of marks in this question were;

- Failing to use correct notation with the loss of dx or du in their proof in part (a)
- Leaving their answer in part (b) in terms of u instead of reverting back to the variable x
- Poor attempts at integrating $\int \frac{u}{(5 + u^2)^3}\,\mathrm{d}u$ with ln or other incorrect expressions common

Question 8

Question 8 was based around the binomial expansion.
Part (a) was familiar and expected, and, as such, well prepared candidates generally scored all the 4 marks. Mistakes were rare and usually centred around errors on the term in x^2 or else slips when multiplying all terms by the factor $4^{-\frac{1}{2}}$. In part (b), candidates were asked to use their expansion of $\frac{1}{\sqrt{4+x}}$ to state the expansion of $\frac{1}{\sqrt{4-x}}$. Errors were common with many choosing to repeat the process from part (a) using the binomial expansion.

Part (c) instructed candidates to use their answers to parts (a) and (b) to find $\frac{1}{\sqrt{4+x}}\times\frac{1}{\sqrt{4-x}}$.

Unfortunately, many candidates did not have expressions of a suitable form and, as a result, did not score any marks here. Others chose to repeat the process of part (a) and find the binomial expansion of $\frac{1}{\sqrt{4+x}}\times\frac{1}{\sqrt{4-x}}=\frac{1}{\sqrt{16-x^2}}=\left(16-x^2\right)^{-\frac{1}{2}}$. Credit was given for such a method.

Part (d) was very discriminating, and many candidates chose not to attempt this part. The link between $\frac{1}{\sqrt{5}}\times\frac{1}{\sqrt{3}}$ and $\sqrt{135}$ and its relationship to the solution $\frac{1}{\sqrt{4+x}}\times\frac{1}{\sqrt{4-x}}\approx\frac{1}{4}+\frac{1}{128}x^2$ was too demanding for many. High achieving candidates, however, saw this as an opportunity to display their mathematical prowess.

Common errors seen in this question were;

- Finding a correct part (a) $\frac{1}{2}-\frac{1}{16}x+\frac{3}{256}x^2$ but incorrectly deducing part (b) to be $-\frac{1}{2}+\frac{1}{16}x-\frac{3}{256}x^2$
- Not achieving a correct starting point for part (c) which needed to be in the form $\left(\alpha-\beta x+\delta x^2\right)\times\left(\alpha+\beta x+\delta x^2\right)$
- Not making the link in part (d) that $\sqrt{135}=3\times\sqrt{15}$

Question 9

This was another discriminating question set with context of a volume of a solid of revolution. Part (a) was another proof where the form of the solution was given. Many candidates made a good start, quoting $V=\pi\int_0^4\left(\cos x+\frac{1}{5}\mathrm{e}^x\right)^2\mathrm{d}x$ before expanding the bracket and using the identity $\cos^2 x=\frac{1}{2}\cos 2x+\frac{1}{2}$. Slips in the expansion were common, as was with the application of the identity. There was also a tendency with some to lose either the π, the limits or the dx.

Part (b) required candidates to find $\int \mathrm{e}^x\cos x\,\mathrm{d}x$. Whilst most made a good start via integration by parts, solutions were often messy and difficult to decipher. Some chose to write down the answer without any working which didn't satisfy the demand of the bold sentences at the start of the question.

Part (c) involved bringing parts (a) and (b) together as well as interpreting the diagram to find the volume of the solid. This was perhaps the most demanding aspect of the paper. Whilst the integration required care, the interpretation that the volume of paperweight being twice the volume of S did prove demanding. Some chose to integrate between 0 and 8 rather than just multiply the integral between 0 and 4 by two.

Question 10

Candidates often find questions on Proof by Contradiction difficult, and this was no exception. Even setting up the contradiction was not well done. It should have gone along the lines of 'assume there is an angle x, $90° < x < 180°$ such that $\left|\dfrac{\cos 2x}{\cos x - \sin x}\right| \ldots 1$ ' but often the domain or inequality was missing or incorrect. Working with the modulus within the inequality proved very demanding with many choosing to ignore it altogether. There were some excellent solutions, however, and many candidates showed how adept they are at solving problems. The most popular routes through this proof were via trigonometric identities producing intermediate lines of an appropriate form. Amongst many acceptable intermediate forms were $|\cos x + \sin x| \ldots 1$, $\sin 2x \ldots \sin^2 2x$ or $\left|\cos\left(x - 45°\right)\right| < \dfrac{1}{\sqrt{2}}$.

When these were reached, most high achieving candidates could then argue the contradiction using the range of the functions $\sin x$ and $\cos x$ within the domain $90° < x < 180°$

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