Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2023

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

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Introduction

This was a fairly typical WMA14 paper. The early questions were very accessible to the well-prepared student with many of the later questions written to test the very best of candidates. Presentation should, and could be greatly improved, not only in the setting out of a proof, but also in making clear all numbers and words in written solutions. It was pleasing to see that candidates are able to make more progress with questions on proof by contradiction.

Question 1

This proved to be a good introduction to the paper, with the Binomial series one of the topics candidates should be prepared for.

The first five marks could be gained for applying the expansion to $\left(\frac{1}{4}-\frac{1}{2}x\right)^{-\frac{3}{2}}$ There were many fully correct solutions. Errors were mainly caused by the fractional coefficients and can be summarised as follows:

- having a factor of $\frac{1}{8}$ rather than 8
- sign errors caused by the $(-2x)$ term

Part (b) was straightforward with most candidates scoring this mark.

In part (c) most candidates attempted to expand $\left(\frac{1}{4}-\frac{1}{2}x\right)^{\frac{1}{2}}$ using the same method as (a).

Generally, if candidates were successful in (a), they were successful in (c). A different method involved multiplying the expansion to $\left(\frac{1}{4}-\frac{1}{2}x\right)^{2}$ by their answer to (a). Most candidates attempting the part by this method scored at least 2 out of 3.

Question 2

Question 2 was based around another familiar topic, implicit differentiation.

Part (a) was straightforward and involved substituting $x = 2$ into the given equation to find the value for *y*. Most candidates scored both marks here, but it was important that they highlighted the fact that the only answer was 9.

Part (b) required candidates to find $\frac{\mathrm{d}y}{\mathrm{d}x}$ from an implicit equation. The first three marks could be gained for correctly differentiating the given equation. For candidates who knew basic techniques, common errors seen included

- differentiating $2^x \to 2^x$ or similar
- differentiating $-4xy \to -4x\frac{\mathrm{d}y}{\mathrm{d}x} + 4y$ instead of $-4x\frac{\mathrm{d}y}{\mathrm{d}x} - 4y$
- and surprisingly differentiating correctly but leaving in the "13"

Once a candidate had differentiated correctly and achieved the two $\frac{\mathrm{d}y}{\mathrm{d}x}$ terms, many could then go on to score all 5 marks.

Almost all candidates who attempted part (c) knew the method. Reasons for dropping the accuracy mark in the solution were due to having an incorrect gradient or errors in the algebraic manipulation of the expression in ln2's.

Question 3

The first two parts of Question 3 were very straightforward.

Part (a) involved a simple partial fraction, and most were able to score all 3 marks.

Answering part (b) successfully was crucial to success in (c). Whilst most candidates knew that $\int \frac{\alpha}{2x-1}\,\mathrm{d}x = ...\ln|2x-1|$ **OR** $\int \frac{\beta}{4x-3}\,\mathrm{d}x = ...\ln|4x-3|$ many were unable to score the accuracy marks for establishing the correct coefficients. For example, an incorrect $\int \frac{1}{2x-1}\,\mathrm{d}x = \ln|2x-1|$ was seen as often as a correct $\int \frac{1}{2x-1}\,\mathrm{d}x = \frac{1}{2}\ln|2x-1|$

Part (c) proved to be very demanding with some candidates unable to make any progress at all. Applying the limits and log rules enabled the more astute student to proceed to a quadratic equation in *k*, which could then be solved to deduce $k = \frac{3}{2}$

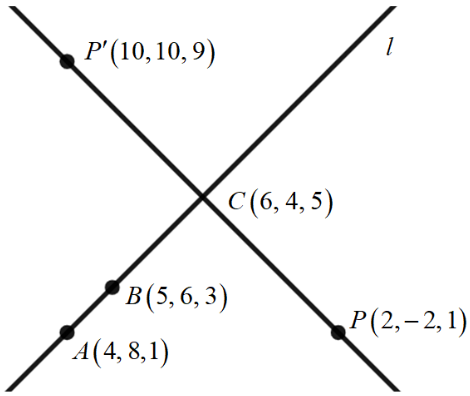
For candidates who made progress, common errors were:

- not achieving an answer to (b) of $\frac{1}{2}\ln|2x-1| + \frac{1}{2}\ln|4x-3|$

- a failure to simplify $\frac{(6k-1)(12k-3)}{(2k-1)(4k-3)}=20$
- a failure to reject $k=\frac{19}{44}$ from the solution pair of $k=\frac{3}{2},\frac{19}{44}$

Question 4

Questions on vectors tend to be very discriminating, and this proved to be no different. Many candidates would be well advised to draw a diagram which would help decide how the points are related to each other (see below).



In part (a), candidates who were able to start generally went on to score at least one mark. The accuracy mark tended to be lost for starting the l.h.s of the equation as $l=$

Part (b) is a standard technique. It involved using the fact that $\overrightarrow{PC}$ and *l* are perpendicular and hence scalar product $\overrightarrow{PC}\bullet\begin{pmatrix}2\\-2\\1\end{pmatrix}=0$. Once applied it became an easy task to find the coordinates for *C*.

Most incorrect attempts involved using scalar product $\overrightarrow{OC}\bullet\begin{pmatrix}2\\-2\\1\end{pmatrix}=0$.

Parts (c) and (d) were often omitted and/or incorrect. A very popular incorrect answer for the coordinates of P' were $(-2, 2, -1)$ in which the negative values of the coordinates for *P* were written out. The easiest way of attempting this part involved using $\overrightarrow{PC}=\overrightarrow{CP'}$.

In part (d) many could score the method mark by finding the distance between their *P*' and *P*. It could also be attempted without the need for finding *P*' by using the fact that $\left|\overrightarrow{PP'}\right|=2\times\left|\overrightarrow{PC}\right|$

Question 5

This question involved two integrals, one by parts, the second via a given substitution. Candidates should have been well prepared for such a question,

Part (i) required the candidates to use integration by parts twice on x^2e^x. It is a well-known technique and most made very good progress. It was common to see an sign error when performing the second integration losing one of the 4 marks.

The substitution in part(ii) was more demanding, but still a standard integration technique. There were some very good answers to this question but common errors that need to be addressed by future cohorts are:

- a lack of accuracy when differentiating expressions such as $u=(1-3x)^{\frac{1}{2}}$
- forgetting to change all aspects of $\int \frac{27x}{\sqrt{1-3x}}\,dx$ to u including the dx
- a lack of algebraic skills in taking a correct common factor out of expressions such as $\alpha(1-3x)^{\frac{3}{2}}+\beta(1-3x)^{\frac{1}{2}}$

Question 6

This question on a differential equation set in context proved to be very demanding, due to the fact that two constants had to be found using the two given boundary conditions.

Most candidates knew how to start, and many knew the form the solution to $\int \frac{d\theta}{(\theta-15)^2}$.

At this point, however, many failed to include a constant of integration and used $-\frac{1}{\theta-15}=-kt$ rather than $-\frac{1}{\theta-15}=-kt+c$. This was a critical error from which there was no recovery.

There were however many pleasing solutions to the question from careful and gifted candidates who used all information to produce a correct equation linking θ and t. There seemed to be fewer instances this series where candidates would attempt to make θ the subject by inverting each term of $\frac{1}{\theta-15}=\frac{9t}{3500}+\frac{1}{70}\quad(*)$.

For those who achieved a satisfactory answer in part (a), most went on to score at least one mark in (b). It is worth noting that the above equation $(*)$ may have been a more suitable equation to find t given $\theta=20$

Question 7

Whilst questions on proof by contradiction have proven demanding in the past, this one seemed more familiar to candidates. Many knew how to set up the proof, gaining the first mark by stating $\sqrt{7} = \frac{a}{b}$ and then squaring. Further marks were then scored by making progress with the proof. Omissions or errors seen included:

- writing $7b^2 = a^2$ but then only stating that "*a*" was a multiple of 7 without mentioning a^2
- failing to proceed algebraically from *a* being a multiple of 7 by setting $a = 7k$
- omitting to mention in the contradiction statement that the integers *a* and *b* had no common factors in the statement $\sqrt{7} = \frac{a}{b}$

Question 8

The last question on WMA14 needs to be demanding. The first 5 marks of this one were very accessible however, and many candidates made progress here. The last 7 marks proved to be discriminating and gave the A/A* candidates an opportunity to show their higher-level skills.

Parts (a) and (b) involved a basic understanding of parametric equations. For those who attempted the question, most achieved these two marks.

Part (c) involved the use of parametric differentiation. Whilst the technique is well known, it was surprising to see the numbers of candidates who incorrectly differentiated $x = t + \frac{1}{t}$ and $y = t - \frac{1}{t}$.

Generally, candidates who could perform this differentiation scored all of the marks here, with only a minority finding the tangent as opposed to the normal.

Part (d) involved finding the volume of revolution under a curve defined by parametric equations. Using the formula $\pi \int y^2 \mathrm{d}x = \pi \int y^2 \frac{\mathrm{d}x}{\mathrm{d}t}\, \mathrm{d}t$ candidates should have been able to integrate the expression in *t* to find the volume generated by the area under the curve. Adding this to the volume of the cone would then produce the total volume. Many careful and well written solutions were seen from high achieving candidates. Common errors witnessed in this part were:

- failing to consider one of the two volumes
- squaring $\left(t - \frac{1}{t}\right)^2$ to $t^2 - \frac{1}{t^2}$
- not involving the $\frac{\mathrm{d}x}{\mathrm{d}t}$ term in their integral
- using *x* limits to the integral in *t*

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