Examiners' Report
Principal Examiner Feedback

October 2022

Pearson Edexcel International Advanced Level
In Pure Mathematics P4 (WMA14) Paper 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 students at: www.pearson.com/uk

October 2022
Publications Code WMA14_01_ER_2210
All the material in this publication is copyright
© Pearson Education Ltd 2022

General

This was a standard WMA14 paper. A well-prepared candidate was able to gain plenty of marks on questions 1 to 7 with questions 1, 2, 3 and 6 in particular, a useful source of marks. The latter questions, written to test the best of candidates, were more demanding. In question 10, for example, a number of candidates were unable to write down the differential equation and hence were unable to start the question.

Report on individual questions

Question 1

This was a good starting question to the paper with many candidates scoring full marks.

The majority of successful attempts began by rearranging to get t in terms of x and then substituting into y. A disappointing number of responses ended up with y in terms of both x and t as they only partially rearranged as far as $t = x(t-3)$ and substituted this into y. There were also a good number of successful responses where t was found in terms of y and substituted into the expression for x. Although the first mark was almost always scored, many candidates struggled to rearrange their equation to make y the subject and some did not even attempt this.

A few candidates thought it appropriate to use calculus and scored no marks.

Question 2

The second question, on partial fractions and integration was extremely well done with the majority of candidates scoring at least 5 marks.

Part (a) was almost always correct. Errors were seen when a small minority of candidates either made slips in their arithmetic to find incorrect values for A and B or else started with an incorrect identity.

In part (b) most candidates knew that $\int \frac{1}{x-2}\ dx = ln(x-2)$ but a common error was to omit the $\frac{1}{2}$ in $\int \frac{1}{2x-1}\ dx = \frac{1}{2}ln(2x-1)$. The ln laws were well known by most and provided the integration was done correctly, most went on to find the correct answer in the correct form.

Question 3

Generally, the candidates did reasonably well on this question. In part (a) most candidates could successfully find vector RQ, although there were some arithmetical errors in the subtraction. Several candidates tried adding the given vectors—or equivalently changing the sign of one vector before subtracting which gained no credit. Of those who subtracted accurately, some had the wrong direction so actually gave vector QR, thus only gaining the method mark.

In part (b) there were a significant number of successful attempts gaining full marks. Most students used the scalar product method. Errors included the use of the wrong pair of vectors. Not all candidates selected the correct directions for their vectors to give the obtuse angle, although some found the acute angle then subtracted from 180°. Those candidates who chose the cosine rule method were almost all successful with only a few calculating the wrong angle.

Question 4

Most candidates attempted at least part (a) of this question on the binomial expansion. The idea of expanding a binomial expansion in x^2 did not cause the same issues as last year, so clearly candidates have learned from previous series. Parts (b) and (c) caused more issues however, so only a minority of candidates scored all available marks in this question.

In part (a) the majority of candidates did make some attempt to take the 4 out as a factor, though some incorrectly wrote 4 or $4^{1/2}$. If this was done correctly many candidates went on to gain the 5 marks available. Reasons for a loss of marks in this part were

- not dividing the x2 by 4 and expanding $(1-x^2)^{-\frac{1}{2}}$
- failing to multiply their expanded $\left(1-\frac{1}{4}x^2\right)^{-\frac{1}{2}}$ by $\frac{1}{4}$
- and the most common error, sign slips leading to $\frac{1}{2}-\frac{1}{16}x^2+\frac{3}{256}x^4-\frac{5}{2048}x^6$

There were many incorrect responses to part (b), with common errors including \$|x| < 4$, $x < 2$ and $|x| < \pm 2$.

In part (c) the use of $x = 1$ in the expansion was the most commonly used successful strategy. Some candidates equated $\frac{1}{\sqrt{4-x^2}}$ to $\sqrt{3}$ followed by an attempt to substitute $\sqrt{\frac{11}{3}}$ into their expansion, although fully correct solutions were not common. Some candidates simply substituted $x = \sqrt{3}$ into their expansion. Many did not appreciate the implication of the request for a **rational** solution and provided a rounded or truncated decimal answer.

Question 5

This question was done well by only the most able of candidates. Whilst a significant number of candidates were able to achieve the first B mark for recognising the correct form of the integral for volume, many candidates were unable to make further progress. When the first mark wasn't achieved it was usually due to a failure to square y, or for a missing π which was not recovered later.

The major stumbling block for the majority of candidates was a failure to choose a correct approach to the integration which was at the heart of the question.

The most efficient way to achieve a correct integration was to recognise the integrand as being the result of a chain rule differentiation of $(2x^2+3)^{-2}$ or else using a substitution $u = 2x^2 + 3$. However, few candidates made this choice and wasted much time pursuing incorrect methods which included, amongst others,

- using integration by parts
- integrating to $ln(2x^2+3)^3$
- expanding the denominator and dividing incorrectly

Candidates who failed to integrate using a correct method could only pick up the 4th mark in the question for using correct limits. Those candidates who did use a correct method of integration still struggled in producing a value for k due to the complexity of the algebra.

Question 6
Part (a) of this question on parametric equations was standard bookwork and a useful source of marks for many candidates. Parts (b) and (c) were found more demanding with many good candidates dropping at least a mark in the question.

In part (a), the vast majority of candidates correctly worked in radians and many identified $t = \frac{\pi}{4}$ as the value of the parameter at *P*. Many of these then went on to find a correct answer and wrote the equation in a suitable form. Errors, when made, were usually as a result of

- incorrect differentiation of either $\frac{dx}{dt}$ or $\frac{dy}{dt}$
- incorrect simplification of a correct $\frac{dy}{dx}$ with $\frac{1}{3\,sec^2\,t} \rightarrow 3\,cos^2\,t$ being common
- use of $x = \frac{\pi}{4}$ in their tangent equation

In part (b), a high proportion of candidates recognised the need to substitute $t = \frac{\pi}{4}$ to obtain the correct value for k to score this mark. However, this part was often left unanswered.

In part (c), only the more able candidates gained two marks, but many were at least able to identify one end of the interval and therefore score the method mark. The lower bound was found more often than the upper bound.

Candidates seemed to recognise the need to use $\frac{\pi}{3}$ at the lower bound. However, many did not realise that the maximum was to be found when $t = 0$ and instead used $t = \frac{\pi}{3}$ for the upper bound, thus $-1 \leq f \leq 1$ was a common response.

Question 7
This was a question on integration with part (i) on integration via substitution and part (ii) using integration by parts. There were more fully correct answers seen to part (i) than to part (ii) but in general, many candidates found this question quite difficult.

As the substitution was given in part (i) most candidates got the first mark for $du/dx = e^x$ or equivalent. Many weaker candidates then failed to gain any more marks as they struggled to write the integrand in terms of u. Those who did manage to get the correct form of the integrand then made good progress scoring many of the 7 marks available. Common reasons for a loss of marks in this part were

- losing the factor 4 in the expression $\frac{4(u+3)^2}{u}$
- failing to employ a correct method for integration, often using integration by parts
- use of the *x* limits, ln7 and ln5 instead of the *u* limits of 4 and 2

Part (ii) was often not attempted, particularly where a student had struggled with part (i). For students who attempted this part, most realised the need to use integration by parts and successfully achieved the first method mark. A common error was then to integrate/differentiate the term cos2*x* incorrectly, losing the accuracy mark. Students who achieved the first M1 mark were often able to continue to the next integration method mark, although errors with negatives and constants usually persisted. The majority of students who achieved the previous marks, recognised the need to collect terms and just lost the final accuracy mark due to sign and/or constant errors. Some candidates failed to realise they required a factor of 3 within the final integral. Fully correct solutions were not common.

Question 8

Many candidates did not attempt this question, and many of those who did merely rewrote the given proof without considering other solutions. Of those who did understand what was expected, most considered only one of the two possible cases. Equating both expressions to 5 was seen more frequently than reversing the 25 and 1. The majority of candidates who did consider both of the other possible solutions scored all four marks. A few lost the final accuracy mark following an error in one of the calculations. The most common error seen was when solving $(3x - y) = 25$ and $(x + y) = 1$. As this gave the same value for x as in the solution, many simply said $y = 18.5$ without checking. Very few failed to give a satisfactory conclusion.

Question 9

Most candidates were well prepared for this question and had a good idea of how to proceed, at least initially. Many scored the first two marks by solving a pair of equations to achieve correct values of λ and μ, albeit with occasional arithmetical slips. The extent to which a candidate adopted a systematic approach early in the question was often a good indicator of their final score.

Having acquired values for the two parameters, most then proceeded to use the values to achieve a contradiction which would indicate that the lines did not intersect. Unfortunately, a fairly high proportion who achieved a pair of conflicting values failed to then conclude that this implied the lines did not intersect. In such cases, candidates could only score the first three marks. Those who at this stage immediately concluded that the lines were therefore 'skew' revealed a lack of full understanding of the requirements for skew lines.

Many candidates did not realise that they needed to consider the possibility of the lines being parallel. Of those that did, some concluded only that $\begin{pmatrix} 5 \\ 4 \\ 8 \end{pmatrix} \neq \begin{pmatrix} -1 \\ 2 \\ 3 \end{pmatrix}$ which was insufficient. A few candidates mistakenly thought that they had to show that the lines were not perpendicular instead of parallel.

Question 10

Many candidates failed to see how to start this question which was based upon a differential equation in context.

In part (a) where candidates were required to set up the proportionality statement, many omitted the constant of proportionality k, thus only gaining the first 2 marks. For those who did manage to write down the correct relationship between $\mathrm{d}r/\mathrm{d}t$ and r, there was an equal number who gave incorrect relationships including $\mathrm{d}r/\mathrm{d}t = kr^2$, $\mathrm{d}r/\mathrm{d}t = k\sqrt{r}$ and $\mathrm{d}r/\mathrm{d}t = k/\sqrt{r}$. Even those who had a correct equation did not always integrate, and those who did sometimes forgot the additional constant of integration. Some candidates also tried to substitute the given conditions without having first integrated.

Those candidates who attempted part (b) usually realised the need to put $r = 0$ and often achieved the method mark. This was a question in context and in this instance, the units were required for both marks to be awarded.

In (c) correct graphs were rare and Diagram 1 was often left blank. Those who attempted it usually sketched either a diagonal negative straight line or a concave curve.

Question 11

Question 11 modelled the shape of a cycle track using an implicit equation. It is very important to note that part (a) was a "show that " question and written to enable access into part (b). In such cases it is vitally important for candidates to show all necessary steps to enable an examiner to award all of the available marks

In part (a) many candidates were able to differentiate $10y^2$ to $20y\frac{dy}{dx}$. To differentiate $(x+y)^3$, one of two methods **was required** to be seen.

Method One (Via the Chain Rule): $\frac{d}{dx}(x+y)^3 = 3(x+y)^2 \times \frac{d}{dx}(x+y) = 3(x+y)^2\left(1+\frac{dy}{dx}\right)$
Method Two (Via expansion and product rules): $(x+y)^3 = x^3 + 3x^2y + 3xy^2 + y^3$ then via differentiation to $3x^2 + 3\left(2xy + x^2\frac{dy}{dx}\right) + 3\left(y^2 + 2xy\frac{dy}{dx}\right) + 3y^2\frac{dy}{dx}$.

Once one of the above two methods were **clearly** seen to be applied, all marks were then available in part (a).

Part (b) used the given result. Many candidates were able to deduce that the numerator needed to be 0 and hence $(x+y)^2 = 36$. Using simultaneous equations, it was then possible to find the negative *y* solution of $(x+y) = 6$ and $(x+y)^3 + 10y^2 = 108x$. Only the very best of candidates were able to produce fully correct solutions to this question

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom