Examiners' Report

Principal Examiner Feedback

January 2023

Pearson Edexcel International GCSE

In Further Pure Mathematics (4PM1)

Paper 02R

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

January 2023
Publications Code 4PM1_02R_2301_ER

January 2023 Pearson Edexcel International GCSE Further Pure Mathematics (4PM1) paper 02R

Principal Examiner Feedback

Introduction

It was pleasing to note that candidates performance was much closer to pre-pandemic levels than in other recent series. There were a good proportion of excellent scripts and many candidates were able to give fully complete, or almost fully complete, answers to the questions on this paper. It was also noted that less able candidates were able to make progress with a range of questions, particularly those towards the start of the paper (especially questions 1, 2, 3, 5). Questions 7, 9 and 11 tested the most able, however there were still some very strong answers seen in these.

Question 1

The first question provided an accessible start to the paper with many candidates able to make good progress with the question.

(a) This required a binomial expansion and many candidates demonstrated that they were confident at performing this. A small number of candidates struggled to work with the $\frac{x}{4}$ in the expansion and neglected to include the fractional part in either some or all of their expanded terms. In a minority of cases a correct method for expansion was followed by incorrect simplification.

(b) Candidates found the second part of the question slightly more challenging. The most common issue was not knowing how to find the value of x to substitute, with $x = 1.035$ or $x = 0.035$ being the most common incorrect substitutions. There were also some candidates who merely evaluated 1.035^8 on their calculators which was not what was required.
For the more confident candidates this part did not prove to be particularly challenging. As would be expected a high number of fully correct answers were seen.

Question 2

This question required candidates to solve a linear inequality (a), a quadratic inequality (b) and give the set of values for which both inequalities held (c). Overall, the question was found to be slightly more challenging than question 1, however there were still a high proportion of fully correct or nearly fully correct answers seen.

(a) As would be expected, many candidates were able to correctly solve the linear inequality. There were, however, a number of candidates who made sign errors in solving or had the inequality sign reversed (generally following a division by a negative number).

(b) The majority of candidates recognised the need to rearrange the given inequality to a three term quadratic and solve this in order to determine the critical values. Most candidates were able to correctly obtain the critical values (although there were sometimes errors in rearrangement), however identifying which regions were required proved to be more challenging with candidates often indicating that x had to be greater than both of the critical values. Some candidates incorrectly used ‘and’ between two correct inequalities or incorrectly combined the two inequalities into a single incorrect statement.

(c) The final part of the question required candidates to identify where both the linear inequality and quadratic inequality were both true. Where candidates had appropriate forms for their answers in (a) and (b) there were a good number who were able to then correctly identify the overlapping regions to give their answer to (c) – often through use of a sketch of a number line. Some candidates only gave one of the two required regions.

Question 3

This question required candidates to show that the given function satisfied the given second order differential equation. There were a variety of different routes through the question as exemplified in the mark scheme. A majority of the students answered this question well as would be expected for a question at this point within the paper.

The most common approach adopted by candidates was to differentiate twice, substituting into the left hand side and right hand side of the given equation to show that they are equal. When differentiating some candidates were able to differentiate correctly to obtain $\frac{\mathrm{d}y}{\mathrm{d}x}$, but then struggled to differentiate again in order to obtain $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ which was surprising given that it required application of the same processes.

Where students struggled with this question it was often because they didn't know how to differentiate a product. There were also sign errors seen when differentiating the trigonometric functions and errors seen with differentiating e^{ax}.

Question 4

In this question candidates were presented with a graph of a curve *C* with equation $y = \frac{2x+q}{x+r}$ and were asked to identify the values of unknowns in the based upon the graph and other information presented. Candidates found this more tricky than the other questions in the earlier part of the paper and often made errors in identifying the values. In part (c) it was notable that a number of candidates made an arithmetical slip in evaluating 2×0 incorrectly putting this as equal to 2.

Question 5

This question was well answered by candidates. It required them to work with the gradient of a line, find the equation of a line, find an equation of a perpendicular line and then find the area of a triangle created by the line and it's perpendicular together with the *x*-axis.

(a) In this part of the question candidates needed to use the given gradient together with the coordinates to show that $p = 3$. Many candidates made a good start with this, but there were some who did not show intermediate working before stating the given conclusion.

(b) Candidates were asked to find the equation of the line between the two given points in a specified form. As would be expected, most were able to utilise an appropriate method to start the calculation and often progressed successfully to obtain a correct equation for the line. A common error was not to write this equation in the required format, most commonly by not ensuring that the coefficients and constant were integers.

(c) Obtaining the equation of the line perpendicular to the one found in (b) and passing through point *A* was generally done well. Candidates were confident in finding the gradient of the normal and in substituting this, together with the coordinates of *A*, into the general form of the equation of a straight line in order to obtain the required line.

(d) This was the more challenging part of the question. Less able candidates struggled to identify a strategy for finding the required area. Candidates who identified the need to find the coordinates of point *C* were generally successful in doing so. Once the coordinates of point *C* had been found some candidates then struggled to see how to find the area, with those that made progress with this often not identifying the straightforward calculation route of area $= \frac{1}{2} \times b \times h$ and performing much more involved calculations or using the shoelace method. Where candidates performed a correct calculation for the area they did not always give the exact value as was required by the question.

Question 6

This was a slightly unusual question on rates of change, but many candidates made a good attempt at it. Most candidates were able to use the correct formula for the area of the sector and then make an attempt to differentiate this, often obtaining the correct result for $\frac{dA}{dr}$, they generally could also find the radius when the length of the arc was $\frac{5\pi}{2}$. Use of chain rule was then slightly more challenging for candidates and some errors were seen.

A small minority added additional steps to their calculations by working with arc length as one of their variables, however they were often able to correctly complete the process if they had taken this approach.

Common errors were in the use of the formula for the area of the sector or for length of arc. There were also a number of candidates who did not give an exact answer as was required.

Question 7

This question required candidates to find perform calculations for a volume of revolution about the *y*-axis and use this to find the unknown a. Many candidates found this a challenging question and responses were generally divided into those which were either fully or almost fully correct and those which were entirely incorrect.

Candidates who knew how to rotate around the *y*-axis were generally able to correctly complete the calculation to obtain a three term quadratic and find the value of a. In a small number of cases the candidates made errors in terms of the integration or substitution leading to an incorrect quadratic to solve. These candidates were still able to get some credit for the application of the correct methods.

The most common error was to attempt to rotate around the *x*-axis. This generally led to complex working which did not make progress towards finding the unknown.

Question 8

This question was on functions of roots of a quadratic equation. There were a good number of very good responses from candidates who clearly understood the methodologies associated with this.

(a) The majority of candidates were able to find $\alpha + \beta$ and $\alpha\beta$ from the given quadratic equation and then manipulate this to give the given result. Only a small minority of candidates were not able to correctly expand $(\alpha + \beta)^2$ and utilise this to obtain the given result for $\alpha^2 + \beta^2$.
(b) Candidates found this part of the question slightly more challenging. There were often errors in attempts to identify an identity that could be substituted into to find *k*. Where candidates

did identify that $\alpha^4 + \beta^4 = (\alpha^2 + \beta^2)^2 - 2\alpha^2\beta^2$ they were generally then able to correctly substitute to begin to find k and attempt to form a three term quadratic. There were some errors seen in moving from the substitution to the three term quadratic which were a mix of algebraic errors (e.g. the expansion of brackets) and numerical errors. A small number of candidates worked correctly but gave the answer as $k = \pm 4$ not recognising that they had been told that k is a positive integer.

(c) As the most challenging part of this question it was pleasing to see that many candidates had made a reasonable attempt. Dealing with the algebra for the sum of the two terms often caused more difficulty than the product. Candidates who obtained values for the sum and product were generally able to use these correctly to form a quadratic equation, although sign errors were seen in this step. Some candidates did not give an equation with integer coefficients.

<u>Question 9</u>

Candidates found this question challenging. There were pleasingly still a good number of candidates who gave correct or fully correct answers, however there was a wide range of different levels of performance.

(a) Many candidates were able to write equations based on the third term of *G* and the sum of the first three terms of the sequence. Most of these candidates were then able to utilise these to form either a three term quadratic or a cubic equation. Candidates who formed a cubic equation often found it challenging to solve this and obtain the correct values for r and a. Those who obtained a quadratic generally had more success in finding r and a, but there were some errors seen in solving the quadratic.
A small minority of candidates incorrectly used the formulae for arithmetic progressions rather than geometric progressions.
The final step in part (a) proved to be challenging with many candidates not able to identify how to show the given result. Some were able to demonstrate that it gave correct terms and a correct ratio which was an acceptable alternative approach.

(b) This part of the question was found challenging by a large number of candidates. Some candidates started with the result in (a) and tried to take logarithms of this in order to give the result required in this part. Where candidates started with the summation formula there were a significant number who made errors when manipulating this to the given result – with incorrect inequality signs in intermediate steps.

(c) Candidates were often able to gain this mark even if they had not been able to successfully complete (b) as they could utilise the given result in order to determine the least value of k.

<u>Question 10</u>

A significant proportion of candidates were able to make some progress on this question.

(a) Most candidates were able to use index laws to demonstrate the required result, although candidates should be encouraged to show the steps in their processes when asked to 'show' something is true.

(b) Having completed (a) many candidates were able to make some progress with the second part of the question with most able to gain the first 2 marks for obtaining a linear equation from the index equation.

Candidates found working with logarithms more challenging. With candidates often making errors in their application of the laws of logarithms or attempting to manipulate the logarithmic equation in a way that was simply incorrect.
Where candidates got as far as the solutions for either x or y some incorrectly rejected the negative value. Another error that was observed was failing to give the solutions in pairs.

Question 11

As with all of the questions on this paper there were some very good responses seen to this question.

(a) Many candidates were able to show the required result without error. In some cases candidates incorrectly used $2\pi r^2$ in their surface area expression rather than πr^2 which led to some candidates arriving at a different result to that given, some incorrectly indicating that they had reached the desired result and some candidates identifying the issue and editing their response to make it correct.

(b) Some candidates did not realise the need to write the volume of the container in terms of r only and so differentiated an expression containing h. Where candidates did realise the need to write in terms of r only they were generally able to make an acceptable attempt to differentiate, then equate to 0 and solve for r. Some candidates used the quotient rule rather than the product rule when differentiating, although this was often correctly completed it did lead to more complicated working than was necessary.
Having obtained a value for r most candidates recognised that they need to demonstrate that this gave a maximum volume and were often able to go on to correctly complete this.

(c) Many candidates were able to find the value for h that corresponded to their r. It was disappointing to see that some candidates had obtained a negative h and did not appear to recognise the issue with this. Some candidates found a value for V, the volume of the container, rather than for h which appeared to be due to not reading the question carefully.

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