Examiners' Report

Principal Examiner Feedback

November 2020

Pearson Edexcel International GCSE

In Further Pure Mathematics (4PM1)

Paper 01

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Introduction

Many candidates found the paper challenging. However, many lost marks needlessly through not reading the questions carefully and/or not showing sufficient working. These are recurring issues that are reported year on year.

Generally, rounding instructions must be followed. Candidates should take care not to use premature rounding which can lead to an inaccurate final answer. Showing working, particularly when solving equations is very important to demonstrate the method that has been used. If the final answer is not correct no part marks can be awarded unless the method used is clear.

Question 1

This proved to be a difficult start to the paper for many candidates and was very rare to see the award of the full three marks on this question. Most candidates knew the formula for product rule and knew how to apply it but most could not deal with differentiating e^{3x^2} and frequently omitted the x from the differentiated expression with $36e^{3x^2}\cos 2x - 12e^{3x^2}\sin 2x$ being the most commonly given answer, followed closely by $36e^{6x}\cos 2x - 12e^{3x^2}\sin 2x$ which was awarded M1A1A0.

We allowed expression that had not been simplified so for example, $6xe^{3x^2} \times 6\cos 2x - 6e^{3x^2} \times -2\sin 2x$ would have also scored full marks.

Question 2

A significant number of candidates knew where to place each line and many good sketches were seen. The question clearly states however; 'Show the coordinates of any point where each line crosses the coordinate axes', yet only a few candidates actually gave coordinates. Some candidates wrote the value of the x or y coordinate where the line crossed the axes which we allowed, but it was rare to award B1B1B1 for all three lines correct and labelled despite the presence of lines in correct positions..

Centres must impress on their students that they must read instructions carefully, as in this case, many candidates understood the command word 'sketch' too literally, and did not process the labelling instructions.

The correct region was a rare sight. The successful candidates who found the correct region were those who generally shaded which side of the line was either in or out of the region and then were immediately able to see the required area.

Question 3

Overall, this was a very well answered question with many responses gaining full marks. It should be noted that those candidates who took the trouble to draw themselves a sketch of each triangle required almost always found the correct values, whereas, those who did not, were usually the candidates who were finding the incorrect length in part (a) or the incorrect angles in parts (b) and (c).

Part (a)

Candidates attempted this well with most scoring 3/3 marks here. Candidates losing the final mark lost it most often to not evaluating $\sqrt{296}$ or writing their answer to a lot of decimal places rather than following rounding instructions.

Part (b)

A minority of candidates attempted to find the wrong angle sometimes found $\angle EAD$ and sometimes $\angle AED$. Most candidates solved this correctly most often by using $\tan\left(\frac{14}{10}\right)$. There were only a handful of candidates who lost the final mark for incorrect rounding.

Part (c)

A slightly larger minority of candidates than in part (b) attempted to find the wrong angle usually $\angle AED$. Candidates solved this correctly most often by using $\tan\left(\frac{14}{8}\right)$. Once again, a small number of candidates lost the mark for incorrect rounding although if rounding was penalised in part (b) then incorrect rounding was condoned here.

Question 4

This was another question which candidates found difficult, and many candidates rarely seemed to know how to approach it.

Part (a)

Those candidates who successfully found the required straight line $y = 4$, generally did so by dividing the given equation through by x^2 and rearranging. The hint here was the presence of the x^3 in the given equation. Those candidates who found the correct equation of the line generally also found the correct points of intersection which were 1.4 and 3.6.

The question clearly states ; obtain estimates, to one decimal place, for the roots of the equation…. , yet more than a few candidates gave answers such as 1.43 and 3.65. Considering that the graph paper has a millimetre square representing 0.1 on each axis, we would never ask candidates for more than 1 decimal place accuracy.

Part (b)

It was very rare to see a fully correct solution here. Some candidates are able to rearrange the expression to arrive at the required straight line of $y = 2x - 1$, but the failsafe method using $x + \frac{5}{x^2} = Ax + B \Rightarrow x^3 + 5 = Ax^3 + Bx^2 \Rightarrow Ax^3 - x^3 + Bx^2 - 5 = 0$ and then equating coefficients $x^3 - x^2 - 5 \equiv x^3(A-1) + Bx^2 - 5$ leading to $A = 2$ and $B = -1$ was seldom seen. We frequently saw half a page of algebra leading nowhere using trial and improvement methods for those candidates who even attempted this part.

Question 5

This question was generally very well done with many candidates scoring full marks here.

Part (a)

Virtually every candidate knew what to do here, although just a few used $m = \frac{\Delta x}{\Delta y}$ in which although the gradients were the same (1 and – 1) we could not credit. In a 'show that' question, a conclusion is **always** required and there needs to be an acknowledgement by the candidate that what was required to have been shown, has been. As always, we accept minimal responses, but a few candidates just found the gradients and left it as that, which scored M1A1A0.

Part (b)

Again, there were many correct and efficient responses here with most candidates simplifying their answers to $6\sqrt{2}$ and $8\sqrt{2}$. We did see some incorrect application of Pythagoras theorem (sometimes adding coordinates) and occasionally, candidates gave answers as decimals, but these were rare.

Part (c)

This part was usually where errors occurred. The shape is in fact a rhombus (we saw very few sketches which are always useful in these questions) and most candidates nowadays default to using determinants to find the area, which was usually carried out efficiently and correctly. Some candidates forgot that the starting coordinates are also required to be the finishing coordinates, and some forgot to divide by 2. There were some careless computations seen with some candidates thinking that $4 \times 0 = 4$, although we allowed one computational error for the M mark in an otherwise correct method.

Some candidates recognised that the shape was a rhombus by virtue of the perpendicular diagonals, multiplied the lengths of the two diagonals found in part (b) but then forgot to divide the product by 2, leading to the often seen incorrect answer of 96 (units^2).

Question 6

Part (a)

Most candidates were able to achieve the first B mark by using the given formula for the sum to find the sum for $n = 1$ although a few candidates did not realise that this was also the value of a. Where this approach was not taken candidates were less successful in finding the first term.

A variety of methods were employed to find d, and then use it to find a. Candidates who found d first (usually from simultaneous equations for the sum to two consecutive sums) were in general less likely to find a successfully.

Many candidates having found a, did not find d correctly, because they assumed that d was the difference between the sum of the first and second term and the first term, and the answer of $d = 21$ was often seen in these attempts.

Part (b)

Most candidates could substitute the values they found in part (a) to the formula for the 20*th* term. However, many used the formula given in the question, or even the general formula for the sum of an arithmetic series, to find the sum to 20 terms. This demonstrates, as ever, the importance of reading the question carefully.

Part(c)

This part was often completed successfully whether or not the correct a and/or d had been found in part (a).

This was only possible for candidates who used the given formula for the sum with p, $2p$ and $(p - 1)$. This nearly always led to the correct three term quadratic.

Other approaches were used but these were dependent on the values of a and d. While a three-term quadratic was produced it was not the right one if the values for a and d were incorrect.

Most candidates were able to solve their quadratic. However, too often candidates achieving the correct pair of answers failed to recognise that p had to be a positive integer and so did not disregard the impossible answer.

Of those candidates who did not achieve the correct quadratic, we gave credit to those who used a correct method to solve their three term quadratic equation. Many candidates use a calculator to solve quadratics, and if the final values are incorrect we have no way of knowing if the candidate knows how to solve a quadratic. It is therefore most important to always show working, and if using the formula, show substitution.

Question 7

Part (a)

For the most part, candidates knew how to complete the square on this straightforward example correctly. There were some instances of sign errors and some candidates wrote $\left(x^2-\frac{9}{2}\right)^2-\frac{25}{4}$ which whilst it was an obvious slip, we could not award the M mark.

Part (b)

In this part we followed through what candidates wrote in part (a). What we did see occasionally, which we could not credit, was $\left(x+\frac{9}{2}\right)^2-\frac{25}{4}$ followed by $x=\frac{9}{2}$ in part (b)(ii) which despite being the 'correct' answer, did not follow from their work and therefore lost the B mark here.

There were as always quite a few solutions using calculus so $\frac{\mathrm{d}y}{\mathrm{d}x}=2x-9=0\Rightarrow x=\frac{9}{2}$ and therefore $y=-\frac{25}{4}$ but candidates must make it absolutely clear that the response to part (i) is $-\frac{25}{4}$ and the response to part (ii) is $\frac{9}{2}$.

Part (c)

Nearly every candidate found the correct coordinates without any problem here.

Part (d)

This part of the question clearly differentiated between candidates and there were many very fluent and efficient solutions. We accepted either line – curve (which is the correct method) or curve – line with the correct limits (or followed through from the coordinates in part (c)).

Virtually every candidate knew they had to integrate, although we did see some solutions with the integral sign with no integration but just substitution of limits. A significant minority used either y coordinates as limits or a more common error was $\int_9^{14}$ although we gave credit for acceptable integration regardless of limits.

We saw just a few candidates leave their answers as 85.3 which lost the final A mark if $\frac{256}{3}$ was not seen in earlier work. Whilst we allowed $85.\dot{3}$ [recurring] for the final mark it is better to leave answers in an exact form as fractions.

Question 8

Part (a)

Most candidates rearranged the given function to $y = \frac{e^x}{2x+5}$ and then applied quotient rule to the result. This part of the question was often correct and we saw many correct differentiated, unsimplified expressions. Bearing in mind this is a 'show' question, candidates must show sufficient work in order for examiners to be sure that a candidate knew how to answer the question. In this case the minimally acceptable response was to factorise the differentiated expression to achieve $\frac{dy}{dx} = \frac{e^x(2x+5) - 2e^x}{(2x+5)^2} \Rightarrow \frac{dy}{dx} = \frac{e^x(2x+5-2)}{(2x+5)^2}$ and then to substitute $y = \frac{e^x}{2x+5}$ in to achieve the required expression.

Some candidates used implicit differentiation which is beyond this specification, and in actual fact achieving the required expression using this method involved more complicated algebra.

Part (b)

A good many candidates achieved the correct value of $\frac{dy}{dx} = \frac{25}{3}$ but a significant minority used the given expression to find $\frac{dy}{dx} = \frac{y(2x+3)}{(2x+5)} = \frac{3y}{5}$ which could gain no credit unless the value of y was found and substituted.

Part (c)

Many candidates used and applied the correct formula for the equation of a line $y - y_1 = m(x - x_1)$ but some did failed to compute the value of y correctly, or not substitute the negative reciprocal of the gradient found in part (b) and finally not leave the equation in the required form. We saw the correct equation of the line in the required form in a minority of scripts.

Question 9

Apart from part (a) this question was found to be very challenging to all but a small minority of the most able candidates.

Part (a)

Virtually every candidate was able to apply either form of the cosine rule to find the required expression for cos *ADB*.

Part (b)

A few candidates picked up B1 in this part for finding $\cos BDC = \dfrac{x^2}{12x}$ but thereafter very few candidates were able to form a strategy to answer this question. Those candidates who were successful used the common angle *C* in triangles *DCB* and *ACB* or the common angle *A* in triangles *DAB* and *CAB*.

Once this had been established the question was actually quite straightforward because they were able to equate both expressions for cos *A* leaving a very simple two term quadratic equation to solve; $x^2 = 54 \Rightarrow x = 3\sqrt{6}$ and therefore the required length $2x = 6\sqrt{6}$

A few candidates assumed that that angle *ABC* was a right angle. Centres should emphasise to their students that these diagrams are not accurately drawn and that candidates should make no such assumptions.

Part (c)

Candidates who were successful in part (b) were then able to carry on with the same strategy to show that $\sin(\theta + \phi) = \sin\phi$

Most correct responses used the fact that the angle $\theta = 28.95...^\circ$ and $\phi = 75.52...^\circ$ $\Rightarrow \sin\phi = 0.968...$ and then using the sin (*A* + *B*) expansion to show that $\sin(\theta + \phi) = 0.968...$. We awarded M1A1M1A0 for these solutions because they are necessarily approximations.

This strategy could also be used by finding the exact values of $\cos\theta = \dfrac{7}{8} \Rightarrow \sin\theta = \dfrac{\sqrt{15}}{8}$ and $\cos\phi = \dfrac{1}{4} \Rightarrow \sin\phi = \dfrac{\sqrt{15}}{4}$ to show that $\sin\phi = \sin(\theta + \phi) = \dfrac{\sqrt{15}}{4}$ so $\sin(\theta + \phi) = \sin\phi$ and in this case full marks were awarded because the method is exact.

Some candidates demonstrated a misconception between the sums of angles, and a frequent erroneous method seen was if *A* + *B* = 180° then cos *A* + cos *B* = cos 180° and then went on to write $\cos A + \cos B = -1$ which led nowhere.

Part (d)

Few candidates even attempted this part, and even fewer were successful.

This part required knowledge of the fact that if $\therefore \sin\phi^\circ = \sin(\theta^\circ + \phi^\circ)$ then $\sin\phi^\circ = \sin(180 - \phi)^\circ \Rightarrow \theta^\circ + \phi^\circ = 180^\circ - \phi^\circ$

We did not accept a solution based on angle values in this part as it made the question trivial.

Question 10

This question also differentiated between the most able candidates with virtually no correct solutions seen in any part of the question. A very few candidates managed to score some marks in each part, but these were isolated examples.

Part (a)

There were two paths to the correct solution using either $A = \frac{1}{2}l^2\theta$ with $l = r\theta$ and $L = 2\pi r$ or using $A = \frac{1}{2}RL \Rightarrow A = \frac{1}{2}l \times L$

Many candidates scored the first B mark by writing down $L = 2\pi r$ but then got lost in a maze of algebra. One difficulty was poor handwriting which led to confusion between

l and *L* and also *r* and *R*. It was also sometimes very difficult to distinguish between *r* and π. This created problems mainly for candidates who became very confused and only a small minority of candidates managed a correct solution.

Part (b)

For those candidates who even attempted this part, many started by quoting various forms of a chain rule which was not required here. We often saw $\frac{dV}{dt} = 1.5$ written but not used in this part of the question and we could not award the B mark seen here, but not used in part (c).

Once candidates found the length of *l* using Pythagoras theorem (not always correctly applied), then they were usually successful in find that $k = 2\sqrt{10}$ and a pleasing number of candidates even concluded this part by writing $k = 2\sqrt{10}$ although we gave credit for this value embedded in $\frac{dA}{dr} = 2\pi r\sqrt{10}$.

Part (c)

Those candidates who attempted this part found it to be the most accessible because they recognised that chain rule was required. Many candidates picked up the B mark here for $\frac{dV}{dt} = 1.5$ used in chain rule, and the two B marks for the correct volume of a cone in terms of *r* only which they then differentiated correctly meaning that B1M0B1B1A0 was a common marking pattern here.

Very few candidates were able to bring the question to a successful solution and all five marks scored here was a very rare sight.

Question 11

Part (a)

Most candidates were able to score marks in this part, although success here was only sometimes followed by success in parts (b) and (c).

We always award the M mark for a correct vector path seen, but not all candidates help themselves by writing down for example, $\overrightarrow{OD} = \overrightarrow{OA} + \frac{1}{2}\overrightarrow{AC}$ which not only helps the examiner know what a candidate is thinking, but also helps the candidate by tracing out the correct path.

However, a good number of candidates scored 5/5 marks here.

Part (b)

Candidates who attempted this part, generally made a meaningful start and picked up the first M1 for the correct strategy, but often did not progress any further.

A number of candidates equated the gradients of *ED* and *DB* with some success effectively introducing the second constant in this approach. This led to partial/complete success depending on the accuracy of answers in part *a*. A significant minority of candidates looked at *OE* and *OA* without much success at all.

Part (c)

There were a variety of approaches here with only some candidates using a vector approach, whereas others compared the areas of triangles *AOC* and *EOB* using the common angle and the known lengths of sides. To gain this mark, candidates needed to use the length of *OC* as being $\frac{1}{4}$ of the length of *OB* and the length of *OE* as $\frac{4}{7}$ of the length of *OA*. We followed through their value of λ in this part. We could not award marks for what was often seen $\frac{\Delta AOC}{\Delta EOB} = \frac{\frac{1}{2} \times OA \times OC \times \sin AOC}{\frac{1}{2} \times OE \times OB \times \sin AOC}$ without any further work.

Another approach that was often attempted was using determinants, but these were frequently incorrect.

It was pleasing to note the number of candidates who were able to virtually write down a correct value of μ by realising that the required ratio was $\frac{1}{4} \div \lambda$ and thereby found the correct value very quickly and efficiently.

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