Examiners' Report

Principal Examiner Feedback

January 2020

Pearson Edexcel International GCSE

In Mathematics Further Pure (4PM1)

Paper 1

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Introduction

These two papers were well balanced with candidates finding paper 1 only slightly more difficult than paper 2. In general, candidates would benefit from:

- Reading the question carefully for
- rounding instructions
- the instruction ‘show that’ - which tells the candidates they must be careful to include every step of their working
- the instruction to use algebraic methods - which rules out the use of a calculator
- looking carefully at angle ranges given in questions involving trigonometrical questions - questions set in radians are best solved using the calculator in radian mode
- Checking work carefully – impossible answers indicate there is an error.
- Drawing sketches in questions involving coordinate geometry.

4PM1 01

Question 1

(a)

Most candidates were able to form both equations correctly $\left[2a+9d=0 \text{ and } 3a+17d=14\right]$ and solve them by either substitution or elimination to show that $d = 4$. The most common slip was $a=-\frac{9}{2}$ which meant that the final A mark was lost. A few candidates forgot to go on and find the value of a, thus losing a very easily gained B mark.

(b)

This part was not as successfully tackled. The most common errors seen were forgetting to substitute $2n$ into $\frac{2n}{2}\left(2\times 48+\left[\mathbf{2n}-1\right]d\right)$ or else equating the formula for n terms with 3 times the formula for $2n$ terms.

We gave credit for solving a quadratic equation from any attempt at equating the two series, so those candidates who were unable to score the first two marks in (b) were at least able to gain an M mark for a correct attempt to solve their quadratic. It should be a warning sign to candidates that if they solve a quadratic for the number of terms in a series (n) and do not achieve at least one positive integer value, then there **must** be an error and an attempt should be made to revisit earlier work to find it.

Question 2

(a)

A surprising minority of students were unable to draw the two given lines. The most common method was using a table of values, but the more obvious method was to find intersections with axes by setting both x and $y = 0$.

We were generous on the accuracy of drawing lines because several candidates were lining up their rulers only with (0, 0) and (1, 1) for the line $y = x$ meaning that by the time the line reached (5, 5) or (6, 6) it was up to one quarter of a square out. More care needs to be taken with drawing lines.

(b)

The correct region was only seen in less than half of the total responses. The lines $y = -2$ and $x = 1$ were usually seen (and indeed B1B0B1B0 was a common marking pattern in this question) but the correct region less so.

Question 3

This was the most successfully answered question in the paper with the majority of candidates obtaining full marks. Hardly any responses to (a) did not realise that $\mathrm{f}(4) = 0$ was required.

In (b) candidates predominantly found the quadratic factor by division, others by inspection. In both cases this was almost always done correctly, and they then went on to find the correct linear factors. However, a significant number lost the final mark by stopping there. This was the only recurring error. The question states 'Solve' and in these cases this was either not taken on board or misinterpreted as asking for the factors rather than the values of x for which $\mathrm{f}(x) = 0$.

Just a few candidates did not read the instructions 'Show clear algebraic working' and just wrote down (without any other algebraic working):

$$(x-4)(2x-3)(3x+1)$$
$$\Rightarrow x = 4,\ x = \frac{3}{2},\ x = -\frac{1}{3}$$

No credit was given for these responses. We insisted on seeing the quadratic factor of $6x^2 - 7x - 3$ as minimal evidence of algebraic working. Nevertheless, this was a very pleasing set of responses.

Question 4

Candidates generally either did well on this question scoring all or 5/6 marks, or scoring just one mark for only the area of the sector.

The question is set in radians and it was pleasing to see that most candidates did actually work in radians. All candidates would do well to understand that there is a purpose in the way a question is formulated.

Of the few who worked in degrees, most converted the angle correctly. Unfortunately however, the correct degree formula for area of a sector was not well remembered and $\frac{45.84^{\circ}}{2}r^2$ was an oft seen error. Candidates need to realise that the solution to questions like this example is far easier using radians.

Most of those working in radians used the correct formula for area of a sector.

The most common approach for calculating the area of the triangle was to find *BC* using $r\tan 0.8$. The sine formula for area of a triangle was also used successfully by those who first used $\cos 0.8$ to find *OC* in terms of *r*.

There were unsuccessful attempts seen where most common error was *AC* = *r*.

Most candidates recognised that subtraction was required to find the shaded area.

Rounding was much less of an issue in this paper than we have seen in the past, and there were only a few occasions where a candidate found the correct value for *r* but failed to round correctly.

Question 5

This was a question of two very distinct parts. In nearly every case part (a) was entirely correct, and in nearly every case, part (b) was not understood and only two marks were achieved.

(a)

Virtually every candidate knew that they needed to equate the equation of the line with the curve and solve for *x*. The very few candidates who lost marks here forgot to find the corresponding values of *y* indicating a failure to read the question carefully.

(b)

There were only two ways of finding the required area; by finding the area of the trapezium and the two individual sides, or by finding the area under the curve between −5 and 5 and then subtracting the area enclosed between the line $y+x=13$ and the curve $y=25-x^2$.

Very few candidates understood how to do this and simply integrated either the line or the curve or a mixture of curve and line and substituted either −5 and 5 or −4 and 3 and hoped for the best. It is critically important to annotate the given sketch (and in questions where one is not given then to draw a sketch) and to decide on a strategy. he first M1A1 were awarded for a correct method seen to find this required area and it was only rarely awarded, and when it was, candidates invariably went on to gain full marks in this question. The most common marking pattern here was M0A0M1A0B0M1A0 [2 out of 7 marks].

Question 6

In general, this question was well attempted. However, once again it is necessary to report that very few candidates drew a sketch which was needed in part (c) particularly.

(a)

Almost all candidates calculated the gradient correctly. A small number of candidates lost the first M in the main for a gradient of the line segment *AB* rather than the required perpendicular gradient to *AB* at the point *B* (2, 2). Almost all candidates demonstrated that they could find the equation of a straight line correctly using in the main $y-2=\frac{1}{2}(x-2)$. It was rare to see candidates using the

$y=mx+c$ method. Some candidates did not read the question and used $\frac{y-y_1}{y_1-y_2}=\frac{x-x_1}{x_1-x_2}$ which

inevitably meant the loss of all five marks here unless they then went on to find the perpendicular at *B* as well.
A small number used the coordinates (3, 0) and a small number of candidates made an algebraic or numeric slip in getting from a correct un-simplified equation of a line to the answer in the required form.
(b)

This part was very well attempted. Most equated the two lines (usually $y = \ldots$) successfully and solved the equation to find the point of intersection of **their** two lines or the two **correct** lines and went on to find their correct/the correct coordinates of point *C*. Their *C* and *A* were then nearly always used correctly to calculate the midpoint. Candidates who did not manage to find the correct equation of line L_1 but produced correct work in this part were able to score the 3 M marks here.
(c)

Candidates found this part the most challenging. The approach calculating two lengths (*AB* & *BC* or *AB* & *MX*) was rarely seen and did not lead to much credit. Most errors were the result from using sides either *MB* or *AM* with *AB* which are not perpendicular. (This is where a sketch would have been of great benefit). Much more successful was the determinant approach and candidates used the correct coordinates of *M* or **their** *M* correctly in the formation and calculation of the determinant scoring at least the two method marks. A few candidates forgot the $\frac{1}{2}$.

Question 7

This question perplexed many candidates, and the most common scoring pattern was B1M0M0M0A0

The responses were grouped into three distinct categories

- Candidates scoring B0 almost always scored 0/5. The most common incorrect attempts were $2\log_7 x^2$ and $4\log_7 x$.
- Candidates scoring B1 but then nothing else or very rarely the method marks. Incorrect attempts to deal with logs included $\log_7\left(8x^2 - 6x + 3 - x - 2\right)$ and an inability to deal with $3\log_7 2$.
- Candidates scoring B1, dealing with $\log_7\left(\frac{8x^2 - 6x + 3}{x}\right)$ AND $\log_7 2^3$ correctly, and then proceeding to a correct quadratic and solution scoring full marks.

Question 8

This question was not answered well, with only very few candidates gaining all the marks available and more than one third getting no marks at all.
(a)
There was a definite misunderstanding of method here where the negative sine value was reversed and then the basic acute angle was found as 31°. The CAST method was then used to try and identify the required answers to the questions, which inevitably created the potential for errors occurring at several stages in the process.

The result of this was that many candidates only found the answer of 143° as they only considered only positive values of $(2x - 75)$ using the method above. Those who went directly to $\sin^{-1}(-0.515) = -31°$ were almost invariably completely successful. Another common unsuccessful method involved expanding $\sin(2x - 75)$ using the compound angle formula, which seemed an unnecessary complication for a 3 mark question, and no useful progress was made in these attempts.

(b)

Many candidates correctly used the tan identity to score the first M mark, and then directly moved to solving $\cos y = -\frac{2}{5}$ where the problems referred to in part (a) [using the positive value of $\cos y = \frac{2}{5} \Rightarrow y = 66.4°$] also resulted in errors. Only a minority of responses showed any attempt to $\sin y = 0$, and in many cases they did not achieve the solution of $y = 180°$ as well as $y = 0°$. The similarity, and at the same time, the significant difference, between the inequalities for the ranges of solutions required in parts (a) and (b) may have been a factor here.

(c)

The correct identity was used in only a minority of responses here where a number of candidates attempted to use the double angle formula with little success. Of those candidates who successfully created and solved the required three term quadratic, very few were able to explain why their values of $\sin\theta$ were unacceptable other than "math error" or "not acceptable", thus losing the final mark. These two explanations scored no marks because candidates were **told** in the question that there were no values of θ that satisfied the given equation. The question was asking candidates to explain **why** there were none.

Question 9

(a)

The great majority of candidate responses to this were fully correct, with the formula seen written out in full [presumably from the formula sheet], the correct value for 'x' substituted into the formula and the correct expression obtained.

Those candidates who were unable to expand the original expression mostly scored no marks on this question. Of those who made some attempt, errors included using (+) $4x$ or just x instead of $-4x$ in the expansion or occasionally attempting to use a different power in the expansion, with $-\frac{1}{2}$ and -1 both seen at times.

(b)

In this part, most candidates set $1 - 4x = 0.76$ and correctly found $x = 0.06$, substituted this value in the correct expansion and found the correct answer, although a significant minority failed to round their answer as required. A common incorrect attempt was to substitute $\sqrt{0.76}$ into their expansion, suggesting a lack of understanding of the rubric 'with a suitable value of x'.

(c)

Very few candidates gained the marks available here even if they had done part (b) correctly, because they did not make the connection between $\sqrt{0.76}$ and $\sqrt{19}$. This would seem to suggest a lack of understanding of the importance of 'hence' in the question. In fact, putting $\sqrt{0.76}$ into a calculator would have shown the equivalent of $\frac{\sqrt{19}}{5}$ and given a strong hint towards the correct method to answer the question.

Question 10

(a)

Although nearly everyone correctly gave $\overrightarrow{OB} = \mathbf{a} + \mathbf{c}$, a significant minority of candidates gave $\overrightarrow{MN} = \frac{1}{2}(\mathbf{c} + \mathbf{a})$ instead of the correct $\overrightarrow{MN} = \frac{1}{2}(\mathbf{c} - \mathbf{a})$, which would seem to indicate a fundamental misunderstanding on their part of the directional nature of vectors. These candidates were then unable to obtain any of the A marks in part (b).

(b)

However, in this part (which carried 8 marks) those candidates grasping that what was required was finding 2 paths for the same vector were nearly always successful. Those who did not realise this inevitably made no further progress, though the B1ft was usually gained (if nothing else) as most responses to (b) began with $\overrightarrow{MX} = \ldots$ and $\overrightarrow{OX} = \ldots$ whatever else followed. Several responses even then equated $\overrightarrow{MX} = \overrightarrow{OX}$

Amongst candidates who knew what to do, comparing two forms of $\overrightarrow{MX}$ was more popular than comparing two forms of $\overrightarrow{OX}$ [perhaps surprisingly since one version of $\overrightarrow{OX}$ was simply μ (**a** + **c**)]. Either way, such candidates were then able to go on to gain full marks, or at least all four M marks and the Bft mark if their $\overrightarrow{MN}$ from (a) was correct.

(c)

This part successfully discriminated at the top of the ability range but was rarely attempted, and correct responses were even rarer. It required adopting a geometric, visual approach. An embellishment of the given diagram, plus bringing into play similar triangles and scale factors would have provided one potentially successful approach. The most successful attempts involved using either discriminants for the areas of quadrilaterals *OABC* (treating it as a unit parallelogram) and *AXNC*, or using the sine rule on triangles *BXN* and *BOC* which was possible because of the common angle $O\hat{B}C = X\hat{B}N$.

Question 11

Many candidates did not attempt this question at all. In addition, there were many poor attempts at it. This may have been partly due to its position on the paper although it was not the most demanding question.

(a)

Many candidates who scored well on parts (b) and (c) did not do well here. In fact, a fair number of candidates ignored part (a) completely.

Of those who attempted the question, most candidates did try to equate 72 to a version of the area of triangle multiplied by the length.

Mostly, the sine area of the triangle was seen. Very few tried to find the height of the triangle using

Pythagoras (this was a slightly clumsier method). The next two marks M1 A1 were almost always gained together. Candidates usually either had a completely correct version for h, or they did not. The remaining part of (a) was even less successful. This is a 'Show' question, but too many candidates did not show **all** their stages of working. A minority also failed to write did not use $S =$ .... in front of their expression thus losing the final A mark.

(b)

The vast majority of those who attempted this part scored all the first 3 marks.

Differentiation was good and we saw very few errors. Candidates knew to set $\frac{dS}{dx} = 0$ and to solve to find the value of x. A minority did not achieve the A mark because they did not round as instructed. It is frustrating that marks should be lost because candidates do not read the instructions carefully. A few of the candidates who had scored on this part did not demonstrate that the value was a minimum. Those who attempted the second differentiation got it correct and knew how to judge that this implied a minimum. A few did the calculation correctly but did not state their conclusion thus losing the final A mark. There are only a few examples of candidates testing the gradient on either side of the x value.

(c)

Those who had found a correct value for x in part (b) usually gained both the marks in part (c).

However, a few candidates did use their value for $\frac{d^2S}{dx^2}$ instead of x.

There were far fewer examples of incorrect rounding seen for this part.

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