Examiners' Report/ Principal Examiner Feedback

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Pearson Edexcel International GCSE
Further Pure Mathematics (4PM0)

Paper 02

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There was plenty of work in this paper for all but the weakest candidates. Most managed to produce attempts at all questions, with the possible exception of question 8, and most seemed to complete all they could do without running out of time.
There still seems to be confusion between degrees and radians in questions such as question 4, where appropriate formulae are required. Equations can be solved in the correct units by changing the mode on a calculator but use of formulae requires a deeper understanding of the units involved. As always many candidates failed to remember that using rounded answers in further calculations can lead to incorrect answers as they may not yield to an answer which can be rounded to the required degree of accuracy such as in question 4(c). It is wise to write down fuller answers before rounding in earlier parts of a question or save a more accurate answer in the memory of the calculator in case it is needed later.

Question 1
This should have been a routine opening question but was an early discriminator as many candidates did not show an understanding of what the perpendicular bisector is. Certainly only a minority of responses seen were fully correct. The "bisector" was the most troublesome part, with the midpoint being omitted by many candidates, even among those who did use the perpendicularity condition. Many simply found the equation of the line through *A* and *B*. Candidates who attempted the gradient of the perpendicular used the $m_1m_2 = -1$ condition correctly in the majority of cases, even in the (not uncommon) cases where the gradient was incorrect. The method for finding the equation of a line was well known, it is just that it was most often applied with incorrect point and gradient.

Question 2
Some candidates failed to get started with this question as they were unable to state the correct equation for the volume of a cone. Even when the formula was correctly quoted often the radius and height ratio was not used correctly, if at all, to obtain the formula expressed in one variable. Many attempted to differentiate their two variable formula, treating the second variable as a constant. The chain rules were very well stated and used. Candidates effectively used $\frac{\mathrm{d}V}{\mathrm{d}t} = 12$ in their chain rule and substituted their $\frac{\mathrm{d}h}{\mathrm{d}t}$ expression. Most worked with the variable *h* and substituted $h = 4$ at the end of their algebraic working.

Question 3

This was the first question on the paper to have a majority of fully correct solutions. The method for solving such simultaneous equations has clearly been well drilled into candidates, and it is only a very few who scored no marks at all. In cases where marks were dropped the most common error was in failing to achieve a correct quadratic due to algebraic slips in, or after, substituting for their variable. This was more common in cases where candidates attempted to substitute for x instead of y, though such cases were certainly in the minority. Also rare were cases of using the quadratic equation in x and y to form an equation to substitute into the linear equation (though a correct attempt at doing so was seen). Another reason for loss of a mark was in failing to obtain the y values correctly, or indeed at all, though again this was quite rare.

Question 4

Part (a) was generally well done although some gave their answer in degrees and sometimes candidates thought that the area of the sector was given rather than that of the triangle. Those who had worked in radians had no problems with part (b); those who worked in degrees were split between those who used the formula correctly in degrees and those who simply multiplied their degrees answer by 10. There seemed to be no realisation that the later gave an absurd answer. Apart from those who mixed up triangles and sectors, part (c) was done well but the last mark was often lost through premature approximation. By this stage the 3 significant figure requirement had been forgotten with 0.6 being a very common answer.

Question 5

The first two parts of this question were accessible to most candidates, with parts (c) and (d) being more discriminatory. Occasional errors of getting (i) and (ii) the wrong way were seen, though it was much more common in (a) than (b). The $y = 2$ equation was the most likely to be found incorrectly. In (b) most of the answers were given in coordinate form. Part (c) proved less accessible to the candidates, though there were nevertheless many partially correct answers. Some candidates just didn't know what to do at all and either left it blank or had very strange attempts of straight lines or similar. Amongst other candidates there were many other minor errors, missing out the coordinates of the crossing points being the most common of these. Also missing one branch, or putting branches in incorrect quadrants was common. However, the asymptotes were usually done correctly with very few cases of graphs crossing asymptotes, though mixing the x and y asymptotes was seen, and graphs which were a long distance away from the asymptotes also occurred. Surprisingly some candidates did not know how to approach part (d). They tried to use the equation of a line through the crossing points found in (b). Amongst those who did know what to do, most used the quotient rule correctly; attempts using the product rule were less successful.

Question 6

Part (a) was completed correctly by the majority of candidates by writing down the three dimensions and multiplying them together. However, as always with this type of question, there were candidates who managed to derive the given answer from totally erroneous working. In part (b) although a few equated V to zero the majority differentiated correctly and equated their result to zero. Working for both solutions from the resulting quadratic was usually seen with no realisation that 31.55 was impossible. The second differential method for justifying the maximum was well known with some candidates substituting both solutions to see which gave a maximum.

Question 7
This was another successful question, with many candidates presenting fully correct solutions, or just losing one mark. The mark most often lost was the final accuracy in (c), as rounding errors gave the angle as either 41.0^{o} or $40.8/7^{o}$. The first of these usually arose from $\sin\theta = \frac{13}{19.8}$, while the second was from the $\cos\theta = \frac{15}{19.8}$ expression. In part (a), if the candidates found the correct height of triangle *AEB*, usually they would answer parts (a) and (b) correctly. Parts (a) and (b) were generally done better than parts (c) and (d). A lot of candidates made mistakes because they did not find the correct angles or they did not round their answers correctly. The question was generally well answered but often not in the most efficient way. Use of the cosine rule in (b) and (d) was common. Candidates would often find the angle *ABE* to obtain angle *ABC* in (b), then use the cosine rule. For (d), candidates would often consider midpoints of *AG* and *CI* with the centre of rectangle *DJIC*, and sometimes do some substantial algebra to decide the appropriate lengths, again culminating in a use of the cosine rule. Indeed, the answer to (d) was the most often incorrect answer, accuracy aside.

Question 8
There was much confusion between the scalar and vector properties of the hexagon in this question. This led to $\overrightarrow{AB} = 2\mathbf{a}$ and resulted in the loss of all the possible A marks in the question. Candidates were very good at producing chains of vectors in order to get around the shape but these were rarely expressed correctly in terms of **a** and **e** due to their original error. In part (c) the ratios were usually understood, although based on their answer for (a), but some forgot the 2 and had vectors $\frac{2}{5}\mathbf{a}$ or $\frac{3}{5}\mathbf{a}$. Very few if any marks were gained in part (d). Candidates had little idea as to how to use the collinearity of the three points and many of the vector equations were formed incorrectly. Even those who could use the given collinearity often failed to realise that they either needed a second vector expression for $\overrightarrow{OQ}$ or needed to make further use of the geometrical properties of the hexagon. Completely correct solutions were extremely rare.

Question 9
The first four parts of this question proved accessible to most candidates, with part (e) being a very good discriminator. The majority of candidates correctly recalled the binomial theorem, with the most common error among those who did not being to have $n(n+1)(n+2)$ instead of $n(n-1)(n-2)$ in the numerators of their coefficients. Proving the identity in (a) did cause some candidates problems, keeping track of the negative in the x^3 term being the usual cause for loss of mark. Occasional instances of no sight of $-x$ led to some scoring zero in this part. Part (b) was usually correctly done, subject to the error noted above. Occasional cases of failing to simplify the expressions, or of omitting the powers of the *k*s, caused marks to be lost. In (c) the most common error was missing the negative sign of the coefficient, though again, cases of this were certainly a minority, and most candidates managed to get the correct value for *k*. Part (d) likewise was generally well done, with occasional slips leading to λ=25 or 1/5 or -5. Possibly most candidates simply evaluated on their calculator, as there was little working shown. Part (e) was badly done even by those successful in previous parts – candidates did not seem prepared for such a question. Few found the correct value of *x* to use. Most who attempted this part did pick the correct expansion to use but it was clear from the size of the value of *x* used by some that the concept of the range of values for which the expansion was valid was not appreciated.

Question 10
Very few responses to this question were fully correct, but almost all candidates managed to score a majority of the marks available, except for those who did not attempt the question or appeared to run out of time part way through. Part (a) was generally done well, although a handful of candidates use the series sum formula instead of the second and third terms. Part (b) was correct for most candidates, with the majority substituting $r=\frac{1}{2}$, although a noticeable number solved the equation (presumably with a calculator) and found the required root. The first three marks in part (c) were gained by nearly all candidates, but the explanation required for the final mark was missing for most responses. $r=0.65$ was correctly recognised as being too large but -1.15 was frequently discarded because it was negative rather than not satisfying the condition for convergence. Part (d) was fully correct for most candidates. Most understood what was required in part (e) but there were a noticeable number of errors in finding 99% of *S* with a significant number of candidates working with 99 alone. Perhaps half of candidates failed to manipulate either the negative or log division (or both) correctly in getting to their answer. Those who were able to solve this equation to get $n>6.64$ knew they needed an integer solution and gave $n=7$.

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