Examiners' Report/
Principal Examiner Feedback

Summer 2016

Pearson Edexcel International GCSE
Further Pure Mathematics (4PM0)
Paper 02

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Grade Boundaries

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International GCSE Further Pure Mathematics Specification 4PM0/02

The two papers were evenly balanced, with similar final grade boundaries. The most difficult question was the final question of Paper 2 and so no candidates suffered as a result of finding themselves unable to tackle this question satisfactorily.
As always some candidates needlessly lost marks by failing to round as instructed or by working in degrees when the answer had to be in radians. The latter is particularly dangerous if exact answers are required as once exactness is lost it can rarely be regained and so accuracy marks are lost.
Candidates should be aware of the hints given in the language used in questions. When a question asks for "possible values" of an unknown there must be more than one possible result. "Hence" (without being followed by otherwise) indicates that a result already found in that question must be used; no marks will be awarded for an alternative method even if mathematically valid. On the other hand, "hence or otherwise" indicates that any mathematically valid method may be used but use of a previous result will lead to an easier solution.
In "show" questions candidates must be careful to show every step of their working; no leaps of faith are allowed. If corrections to working are needed candidates must ensure that this has happened throughout the question; any error seen in the working will lose the final accuracy mark.

Question 1
Both parts of this question were accessible to the vast majority of candidates with many gaining full marks. Very few were unable to quote both formulae correctly; the most common error was forgetting to square the lengths of the sides in the cosine rule. It was evident that some candidates did not realise that the largest angle was opposite the longest side and they calculated all three angles, frequently failing to use the angle sum of a triangle for the third! A few having calculated all three angles then failed to identify the largest angle which resulted in the loss of the final accuracy mark.

Question 2
Overall this question was very accessible and quite often resulted in full marks being awarded. Candidates occasionally worked with column vectors but the strong preference was for using **i** and **j**. In part (a) the majority of candidates understood how to attempt the question and obtained -3**i** + 4**j** or 4**j** – 3**i**. A few had the signs the wrong way around and this was sometimes a careless error or followed an incorrect vector equation such as $\overrightarrow{OA} - \overrightarrow{OB}$. Part (b) showed that most candidates understood the properties of parallel vectors but they often still struggled to find the correct value of λ. Some had completely correct working but ended up by writing - 4 (the scalar multiple) as their answer without linking back to the actual question. Those who wrote the result as 4**j** – 3**i** in part (a) sometimes ran into problems here as they tried to compare the wrong coefficients. The fact that both 3 and 4 are factors of 12 lead to a few problems with several candidates working with a scalar multiple of +/- 3. There were plenty of fully correct attempts for part (c). However, not everyone understood the term 'unit vector' and so concentrated on the word 'parallel' instead. Therefore, examiners saw several answers which were not unit vectors but were scalar multiples of $\overrightarrow{AB}$ or $\overrightarrow{PQ}$. Those candidates who recognised what was required almost always correctly found an appropriate length and this was usually 5 although several

worked with $\overrightarrow{PQ}$ and got 20 instead. Unfortunately, having found the length, not everyone knew exactly what to do with it and there were a handful of inverted vector fractions with the length on the top.

Question 3
In this question over half of the candidates were able to score full or almost full marks. Understanding the need to form the fractions in part (a) was key to candidates' performance, although there were then a significant number of candidates who were inaccurate in their expansion of brackets. In part (b) those who achieved the correct values of *x* could also achieve the values of *r,* although the answer $x = 0$ was discounted by a number of candidates, so they never found $r = -1$. The most common mistake of those who gained full marks in parts (a) and (b) and then did not do so in part (c) was to use the value of *r* for the value of *a*. There was also a noticeable number of candidates who did not understand the requirements for a convergent series, using $r = -1$ in the correct formula, but gaining no marks.

Question 4
Many candidates gained full marks here. The majority were able to apply the product rule for differentiation and were able to differentiate both terms correctly. The most common error was to omit the minus sign. Very few quoted the product rule and many had "invisible" brackets.

Question 5
This question seems to be one of the questions that candidates were best prepared to handle. The majority of candidates showed part (a) in an appropriate manner provided they completed a clear statement of the areas of each face and combined them correctly. They also differentiated the area function successfully in part (b) and came up with the correct result. There were some candidates who did not justify why this value of *x* produces minimum area, including some who decided that as 4.94 was positive this must show a minimum. There were several cases where the nature of the turning point was not made clear which was a wasted mark since the work had invariably been completed and a conclusion omitted. Part (c) was again apparently easy to answer with few candidates not rounding to the required degree of accuracy after finding the correct value for *x* in part (b).

Question 6
In part (a) the majority were able to equate and form a correct three term quadratic which they then factorised correctly. Incorrect quadratics were solved using the quadratic formula but some then made errors in substitution or used +b rather than –b which implied an incorrect formula if the general result had not been quoted first. The final A marks were often lost because candidates did not find the *y* coordinates. In part (b) many found the integral of the 'line - curve' and successfully achieved both marks for this. A few used their values of *y* as the limits and some only integrated the line or the curve which resulted in zero marks. Only a few gave a negative area as the final answer.

Question 7
Many candidates gained full marks on this question but a surprising number of candidates didn't know how to start to approach it. Part (a) was usually well answered although some didn't realise the need to differentiate and substitute $t = 2$. Instead they substituted $t = 2$ into the

expression for v. Those who realised that the minimum occurred when $\frac{dv}{dt} = 0$ were able to solve the equation and substitute for t in v. Some rounding errors resulted in the loss of the accuracy mark. Most candidates who attempted this question gained the mark available for part (c). In part (d) many did not equate v to 7 to find t and used either $t = 2$ or $t = \frac{2}{3}$ with a consequent loss of marks. All those who attempted this could integrate accurately. Some used indefinite integration rather than definite but they were able to find the value of the constant.

Question 8

Part (a) was generally answered well with many candidates aware of the term 'asymptote' and what it meant in terms of the curve equation. Examiners also saw a few candidates write $3x + 2 = 0$ instead of the predominant $x = -\frac{2}{3}$. Many candidates were able to achieve full marks for part (b). Typical errors were in the initial differentiation and sometimes in solving the quadratic but most occurred when candidates attempted to simplify their differentiated expression. When using the quotient rule, this was usually -3 appearing in the numerator instead of +3. Fortunately for candidates incorrect simplifications usually only cost them the final 3 A marks. The quotient rule was the standard choice although some opted for the product rule and, of those that did, most made decent progress. Examiners reported seeing a small number of candidates who only ever worked with the quotient rule numerator without writing down the denominator. This was most likely an incorrect application of the product rule. The vast majority of candidates gained the mark for part (c). In contrast, part (d) was the least accessible part of the question due to the use of a function with an oblique asymptote. Most candidates were able to score the second B mark for the asymptote but that was all. The majority of candidates did not take into account the fact that they had found two turning points in part(b) and most simply drew a version of a reciprocal function (in two parts with an asymptote) without turning points and then included the coordinates they found earlier. A very small number of candidates produced a fully correct graph with fully correct labelling. Success in part (e) usually depended on the differentiation in part (b) being correct although examiners saw several candidates start again without linking back to part (b). A handful of candidates only produced differentiation in part (e), having failed to understand what a 'turning point' is. The method of producing the equation of a normal from a point and a derivative was very well understood and so the M mark was awarded to the majority of candidates who attempted part (e). Candidates clearly favoured the use of $(y - y_1) = m(x - x_1)$ over the use of $y = mx + c$ and typical errors were caused by incorrect earlier derivatives and working with the tangent gradient.

Question 9

Parts (a), (b) and (c) were generally very well answered, with candidates using the appropriate identities correctly to produce the required results. Where candidates started badly, or lost their way subsequently, many tried making small but completely unjustified adjustments to get to the given result. The great majority of candidates showed that they had an idea of how to approach part (d), correctly using part (c) to get to $\cos 3\theta = \pm\frac{1}{2}$. A noticeable minority used degrees and converted to radians at the end but a significant number of candidates did not give all three solutions. There were a small number of responses where candidates tried to directly solve a cubic equation, presumably using a calculator, but none were seen with the correct answers in terms of π. Responses in part (e) divided into those that recognised the need to use the identity from part (c) and those that did not and consequently were usually unsuccessful. Of those that used the appropriate approach a noticeable number lost marks in part (e)(ii) by not substituting the lower limit. A significant number of candidates, perhaps as many as half, used the equation from part (d) to produce an incorrect function they then proceeded to integrate and substitute the given values.

Question 10

This was a challenging question for candidates with many blank responses and others with a multitude of partially complete methods and plenty of crossing out. Unpicking what candidates were trying to do was often tricky and very time consuming. If an attempt was made then a typical mark profile for Q10 was 1000 101000 11.

Of those who attempted part (a), the first B mark was often the only mark gained. While these candidates were familiar with the geometric relationship between h and r, they struggled to progress from $\frac{\mathrm{d}V}{\mathrm{d}t} = 0.4$ to $v = 0.4t$ and to form an appropriate equation in order to find h or h^3. Part (b) appeared to be the least accessible part of the entire paper with many responses either blank or, despite lines and lines of working, only achieving the M mark for a suitable chain rule expression, which was sometimes shown in two parts, and occasionally the B mark as well. Despite the problems many candidates experienced with this question, it was pleasing to see several concise solutions which demonstrated an excellent understanding of the techniques involved. Examiners reported seeing just about every possible approach (apart from trying to work backwards) and it seems that at least one candidate was successful with each one. Several candidates were able to use implicit differentiation to produce fully correct solutions. Apart from the method in the main scheme, most candidates who had an idea of how to approach the question used a 3-term chain rule expression for $\frac{\mathrm{d}A}{\mathrm{d}t}$. There were also some who only used the chain rule at the end after extensive algebraic work and ended up with a very neat final line of $\frac{\mathrm{d}A}{\mathrm{d}t} = \frac{\mathrm{d}A}{\mathrm{d}V} \times \frac{\mathrm{d}V}{\mathrm{d}t} = \frac{2}{h} \times 0.4 = \frac{4}{5h}$. A minority of candidates used substitution to form an equation for A in terms of t which was then differentiated once. However, the required differentiation and algebraic manipulation was difficult and those who attempted this often lost track of the required indices for certain parts of their expression or they failed to multiply by $\frac{18}{5\pi}$. Otherwise, this was a neat and concise approach. For the final question on the paper, part (c) was quite accessible. Candidates were given all of the formulae needed to answer the question and they just needed to realise that and put everything together. However, as many candidates had struggled with part (b), they often made no attempt at part (c) or their working contained careless errors. Typical errors were a failure to take the cube root of h or to use $\frac{4}{5} \times h$ instead of $\frac{4}{5h}$ and also working with $h = 2.25$ which lead to $\frac{\mathrm{d}A}{\mathrm{d}t} = 0.356.$ There were also some who didn't give their answer to the required accuracy and opted for 0.35 or 0.36 instead which may suggest that they were treating the leading zero as being significant.

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