# Examiners' Report/
# Principal Examiner Feedback

January 2012

International GCSE Further Pure Mathematics (4PM0)
Paper 01

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# International GCSE Further Pure Mathematics
# Specification 4PM0
# Paper 01

## Introduction

Concise and accurate answers were seen to all questions but the general impression was that candidates found the paper rather challenging. Those with a reasonable knowledge and understanding of basic skills scored well on the single part questions but were not always able to link a variety of ideas to complete the longer problems successfully. Most candidates showed persistence without wasting too much time on non-productive work. Sufficient working was usually shown to support the answers given. Numerical results were usually stated to the level of accuracy required.

## Report on individual questions

### Question 1

A surprising number of candidates treated the question as if they were required to solve a pair of simultaneous equations, sometimes concluding with a statement that the lines were perpendicular because there was a point common to both lines. Writing the equations in the form $y = mx + c$ was certainly the most productive method of finding the gradient of each line, though some used calculus and others found points on the lines to do this. Those who found the gradients nearly always knew that the two values should have a product of -1.

### Question 2

Fractions were cleared well. The most frequent mistake was losing a sign to give $x(x+2) - x + 1 = 2(x+1)(x+2)$, sufficient to gain a method mark, but incomplete equations were also seen, especially $x(x+2) - 1(x+1) = 2$. The quadratic formula was applied correctly in most cases and roots were usually stated to the required accuracy of 3 significant figures. Some answers were truncated, leading to -3.61 for the smaller value.

### Question 3

The quadratic expression was frequently factorised correctly. A minority of candidates used the quadratic formula to find the critical values for the inequality. Both methods were usually correct with just a few candidates getting the signs wrong. Some solutions stopped at this stage and others simply stated $x < -\frac{1}{3}$ and $x < \frac{7}{2}$ without having any strategy for finding the correct range of values. A simple sketch graph often accompanied the correct answer.

## Question 4

Relatively few candidates were able to go directly to the coefficient $\frac{10!}{7!3!}1^3\left(\frac{1}{\sqrt{3}}\right)^7$. It was much more common to see at least the first eight terms of the expansion written out. Some candidates even spent time simplifying all terms rather than concentrating on the one coefficient that was required. Mistakes were not uncommon amongst candidates who tried to complete the whole expansion. There were a few lengthy attempts to multiply ten brackets together.
Those who made a valid start usually evaluated 120 correctly but they had more difficulty simplifying $(\sqrt{3})^7$. Rationalising the denominator also caused difficulty. Some candidates just moved the surd to the top of the fraction to give $\frac{40\sqrt{3}}{9}$ whilst others simply left the answer as $\frac{40}{9\sqrt{3}}$.

## Question 5

The single term $2xe^x$ or $2xe^{x-1}$ sometimes appeared as the answer to part (a) but most candidates recognised the need to use the product rule and correct answers were frequent. Similarly, $5(3x^2+4x)^4$ was given occasionally as the answer to part (b). Others tried to simplify the expression to $x^{15}+2x^{10}+3^5$ or $x^8+2x^7+3^5$ before attempting to differentiate. The majority of candidates did try to apply the chain rule and they achieved a good rate of success, though brackets were occasionally omitted around the term $3x^2+4x$ and $5(x^3+2x^2+3)^4+(3x^2+4x)$ was also seen.

## Question 6

The table was normally completed accurately to 2 decimal places and the points were plotted reliably. The most common mistake was to work in degrees. Each of the missing $y$ values was then given as 2.99 or 3.00, which clearly did not fit in with the expected shape for a cosine curve.

There were various outcomes to part (b). Many made no attempt and others felt that they could find an algebraic solution to the equation. Some did try to achieve a useful rearrangement but many mistakes were made, such as $2x=1+2\cos\frac{x}{2} \Rightarrow 2x=3\cos\frac{x}{2}$. Those who used the arrangement $3x-1\frac{1}{2}=3\cos\frac{x}{2}$ usually drew the correct straight line to find an acceptable value for the root. It was almost as common to write the equation in the form $2x-1+\cos\frac{x}{2}=3\cos\frac{x}{2}$. This was less useful for the graphical solution since it meant drawing another curve, but it was accepted. The final two marks were not awarded if $y=2x-1+\cos\frac{x}{2}$ was drawn as a straight line. No credit was given for a root obtained without the use of correct graphs.

## Question 7

The coordinates for $A$ and $B$ were usually correct. Asymptotes were also found reliably, often after a considerable amount of working. In fact, $x = 3$ can be written down immediately and $y = 2$ comes directly from $y = \frac{2x-3}{x-3} \to \frac{2x}{x} = 2$ as $x \to \infty$. Mistakes in parts (a) and (b) inevitably caused difficulty with the sketch but those who had found correct intercepts and asymptotes usually knew what shape to draw. The most common omission was failing to label the $x$-coordinate of $A$.

It was good to see candidates moving on to part (d) regardless of any difficulties they had found with earlier parts. The differentiation was done well and this usually led to a correct equation for the normal. It was not uncommon to see working for the perpendicular bisector of $AB$ instead of the normal.

The final part was answered well, with just a few numerical errors, frequently providing method marks even for those who had struggled with the normal. A few candidates misunderstood what was required and found where their normal crossed the $x$-axis.

## Question 8

Candidates were frequently muddled by having two different equations to consider. There were various attempts to combine the two equations or to compare the coefficients. This led many candidates to the value of 15 for $k$. It was not unusual to see $\alpha + \beta = -m$ and $\alpha + \beta = -h$ on the same script, occasionally with incorrect signs. $\frac{\alpha}{\beta}$ and $\frac{\beta}{\alpha}$ were often added and simplified to give $\frac{(\alpha+\beta)^2 - 2\alpha\beta}{\alpha\beta}$. This earned two marks when done in part (b) even though candidates were not always able to use the result productively. Those who did identify it with $-h$ usually found an acceptable expression for $h$ in terms of $m$.

Problems with part (b) did not deter many candidates from attempting to find values for $\alpha$ and much success was achieved. Earlier difficulties sometimes blocked further progress but many candidates did use their values from part (c) to complete the question successfully, gaining method marks even if their signs were wrong.

## Question 9

The simple looking diagram with plenty of right-angles was welcomed by many candidates. They used Pythagoras' theorem well to find lengths for the sides of triangle $BCD$ and usually went on to find the required angle using the cosine rule. Most maintained accuracy to reach an angle correct to 1 decimal place but there were instances where side lengths were rounded to 2 significant figures, leading to an answer of $70.4^{\circ}$. These candidates also lost accuracy marks for the sides unless they had shown exact values for the squares of the sides or evidence that the lengths had been found correctly to at least 3 significant figures. Methods to find angle $BDC$ were not always sound. Some treated triangle $BCD$ as right-angled and others thought that $\angle BDA + \angle ADC = \angle BDC$, treating the diagram as two dimensional.

A suitable method was normally applied to find the area of triangle *BDC*. The wrong sides were sometimes used with the angle from part (a), but a correct area was frequently found. The same general formula was occasionally used in part (c) but most candidates identified the right-angle at *A* to find the correct area of triangle *DAC* using $\frac{1}{2}$base × height. Only the more perceptive individuals made use of this area to find the exact length of *AE*. Other correct approaches achieved an inexact value of 4.24 but this gained only one of the two marks available. There were also plenty of incorrect methods, often based on the assumption that *E* was the mid-point of *CD* or $\angle DAE$ was 45°.

It was encouraging to see that the majority of candidates who attempted the final part were able to identify $\angle AEB$ as the angle between the two planes. The most common incorrect choices were $\angle BCA$ and $\angle BDA$. Correct answers were not common due to earlier mistakes but three of the final four marks were available even with an incorrect length for *AE*. Accuracy was often lost when less efficient methods were used, which usually involved the length *BE*. Care is needed with trigonometry questions to ensure that calculators are set to work with angles in degrees.

## Question 10

Most candidates were able to make a sensible attempt to find the two vectors in part (a) but there were many errors, especially with signs, and there was a tendency to over-complicate the working. A few candidates were unable to use the ratios correctly. Similar problems reduced the success of finding two expressions for $\overrightarrow{AT}$. The first was often left as $\overrightarrow{PT}$ or given as $\frac{3}{4}\mathbf{a}+\lambda(\frac{5}{12}\mathbf{a}+\frac{2}{3}\mathbf{c})$, losing the negative sign for $\overrightarrow{AP}$. The second was more likely to be correct but $\mu(\mathbf{a}-\mathbf{c})$ and $\mu(\mathbf{a}+\mathbf{c})$ were seen periodically.

A significant minority of candidates were unable to proceed to part (c) but those who were familiar with the technique of comparing coefficients for two equal vectors usually made good progress. Mistakes in the subsequent algebra were common. Few of those who obtained a correct value for $\lambda$ managed to give the final ratio, often presenting lengthy working which tended to lose sight of the rules for manipulating vectors. It was possible, of course, to simply write down the required ratio after finding the value of $\lambda$.

## Question 11

Many candidates struggled to understand what this question required. Attempts in part (a) often used a formula for the volume of a hemi-sphere, cone or cylinder. Those who realised that calculus was needed tended to confuse their variables even if an appropriate integral could be identified. Limits of 0 and 5 were common.

The given volume was usually differentiated correctly though it was surprising how often the product rule was used to obtain the result. A significant number of candidates did not make a serious attempt at the last two parts. Those who understood that different derivatives were involved usually linked them correctly with the chain rule. Appropriate values were substituted and a reasonable number of correct answers were seen, though some were only given to 2 significant figures. Very few candidates gave a complete solution to part (d), failing to observe that $W=\pi(10h-h^2)$.

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