Examiners' Report/
Principal Examiner Feedback

June 2011

International GCSE
Further Pure Mathematics (4PM0)
Paper 01

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Introduction

The paper achieved a good balance, offering nearly all candidates the opportunity to demonstrate some knowledge on a variety of questions without neglecting the need to discriminate at the top end of the ability range. No complete question stood out as causing widespread difficulty. The structure of questions was usually recognised, so candidates made good use of their work in the opening parts to help them complete the longer answers.

The best answers were concise and elegant but the other extreme was also seen, making it difficult for examiners to follow the intended method. It was pleasing to note that very few answers appeared without sufficient working. Candidates were generally sensible about abandoning attempts that were becoming too long and complicated, realising that time would be better spent on a different approach or another question.

Report on individual questions

Question 1

This was a successful question to start the paper. Solutions usually took the simpler option of eliminating y and factorising the subsequent quadratic equation. Relatively few mistakes were seen in this procedure, but some candidates did miscalculate the y values or overlook them completely.

Question 2

There were two quick marks available in part (a) to those who saw that a substitution of $x = b$ in the given identity led directly to the required result. Many tried to rearrange the given identity and some used the result they were trying to prove as part of their working.

The second part of the question was familiar to many candidates and solutions usually started with a correct change of base. This frequently led to an accurate answer but there were some difficulties with the algebra, especially confusing $(\log_8 x)^2$ with $\log_8 x^2$. Those who included the non-integer root in their answer were not penalised.

Question 3

The differentiation in part (a) was usually completed successfully using the product rule, although a small number did give $\frac{dy}{dx} = 2e^{2x} \cos 3x$. Many repeated the procedure for each of the products and obtained a correct second derivative, though mistakes were more common at this stage. Others became confused, sometimes failing to realise that the product rule was needed again or ending up with products of four terms. There was rarely any difficulty in showing that a correct derivative could be written in the required form.

Question 4

The manipulation of trigonometric formulae regularly defeats a minority of candidates, but for most of the students part (a) was a straightforward first mark. There was also much success with part (b), although answers were sometimes left as $\cos^2 A - \sin^2 A$. This gained no mark unless an attempt was made to replace $\cos^2 A$ with $1 - \sin^2 A$. Many neat and direct solutions to part (c) were seen. Indeed, most working that started with a correct expansion of $\sin(2A + A)$ was successful in the end. A typical incorrect starting point was to treat $\sin 3A + \sin A$ as $\sin(3A + A)$.

Question 5

The value of a was found correctly by most candidates, though some of them achieved the result by inefficient methods. The x-coordinate of B was normally approached by finding the equation of l and putting $y = 0$. This procedure was completed well, providing accurate values to use in part (b). Some students used the gradient of $-\frac{5}{7}$ to move from $A(5, 5)$, concluding that B must have coordinates $(5 + 7, 5 - 5)$.

Just one mark was available for the volume of revolution created by the line AB. This was easily obtained by candidates who recognised the volume as a cone. Many chose to integrate instead but they were rarely able to follow the details through accurately, even if they started with the correct integral. Greater success was achieved with the integral for the curve. Mistakes included $\pi \int 25x^2 \, dx$, $\pi \int \sqrt{5x} \, dx$ and various attempts to integrate between the limits 0 and 12 for either the line, or the curve, or some combination of both. A few candidates treated the volume of revolution for the curve as a hemisphere.

Question 6

Work on arithmetic series tends to be done well and this question was no exception. Candidates were familiar with the formulae for the n^{th} term and the sum of n terms, and these were used efficiently in part (a), usually giving a correct pair of linear equations. Accurate values for a and d generally followed from these, with just a few candidates solving $-5d = 50$ to give $d = -5$.

Solutions to part (b) usually started with a correct inequality. Some made mistakes in the simplification but many maintained accuracy in their algebra and went on to find the critical values of 5 and 14, usually by factorising rather than using the quadratic formula. The answer was typically left as $5 \leq n \leq 14$. This did not gain the final mark unless some indication was given that the solution set was only the integer values in this range.

Question 7

Most candidates were able to factorise the equation in part (a) to find the correct values for p. Some link between part (a) and part (b) was invariably seen but it was not always correct. One of the more common mistakes was to put either one or both of the values for p equal to 3^{2x} instead of 3^x. Some candidates were unable to solve the equations $3^x = 0.2$ and $3^x = 2$; those who could generally observed the instruction to give the answers to 3 significant figures.

Some solutions to part (c) showed clearly how the two curves could be solved together to give the equation in part (b) and they usually continued to provide an accurate set of coordinates. Any loss of accuracy was likely to be caused by using rounded x-values to calculate the y-coordinates, rather than the exact values of 3^x. Other attempts were vague about combining the equations of the curves. They often became confused between the values of x, 3^x and 3^{2x}, leading to answers like (2, 8) and (0.2, –1). A significant minority of candidates failed to establish a link with part (b), often making fundamental algebraic mistakes, such as writing $5(3^x)$ as 15^x.

Question 8

There were a few mistakes finding the gradient of AB but most candidates were able to work out a correct equation for the line and answers were usually given in the required form. Results for the perpendicular bisector were also good. A few candidates used the coordinates of A or B instead of the midpoint; some assumed that the constant term was $\frac{19}{4}$, as in part (a); and there were instances of incorrect gradients, especially $\frac{1}{4}$ and $-\frac{1}{4}$. The equation of l was generally used correctly to give the coordinates of C and D.

Most candidates found a reasonable strategy for calculating the area of the kite but mistakes were frequent. A common approach was to split the figure in to two triangles. Those who multiplied the diagonals sometimes failed to divide the product by 2. Others tried multiplying the lengths of AC and BD, possibly thinking that these were the diagonals. Attempts to use a matrix approach often failed because points were listed alphabetically rather than in cyclic order. Incorrect and inadequate diagrams were at the root of many of the problems.

Question 9

The asymptote $x = 2$ was often written down on sight, as intended, but some candidates felt that much more work was involved. A few students did not understand what was required to find the stationary points, typically working out the intercepts on the x-axis and y-axis instead. The majority of solutions did attempt to differentiate and success with the quotient rule was usually good, though there were some sign errors and $(3x-6)^2$ was occasionally omitted. Those who differentiated were likely to put their result equal to 0 and they normally factorised the resulting quadratic equation correctly to give accurate values for x. Numerical mistakes were a little more common with the values of y.

The coordinates of A were found reliably but errors were frequent in working to find the gradient of the normal at A. The greatest problem was using losing a factor of 6 and substituting $x = 0$ in to $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{(x-3)(x-1)}{(3x-6)^2}$. Candidates generally knew how to use their equation for the normal in part (d) and subsequent simplification was done quite well. Those who stated $x = 0$ as an alternative coordinate for B were not awarded the final accuracy mark.

Question 10

The most successful candidates with this question invariably annotated the given diagram carefully or drew separate diagrams for each part. They also labelled their working clearly. Many attempts were much less organised and mistakes were commonplace in these.

Side lengths expressed as multiples of x were the source of many problems. The length of AC was regularly shown as $\sqrt{6x^2+8x^2}$. This was sometimes simplified to $10x$, but $14x$ and $\sqrt{14}x$ were common. A reasonable number of candidates used an appropriate method to find VN with just a few forgetting to halve their length of AC when working in the triangle AVN. The multiples of x caused further difficulty when Pythagoras' Theorem was used to find AV. Few candidates noticed that the triangle AVC is equilateral.

The angle required for part (c) was often identified correctly, though 60° for angle VAN was given occasionally. Methods to find the angle usually had merit but incorrect results from previous parts were a hindrance. Fewer candidates knew which angle to calculate in part (d), often making no attempt or working to find an angle in triangle AVC or triangle AVD. Some gave their answer as 60° or 120° with little or no working. When the correct angle was identified, it was usually calculated correctly and given to 1 decimal place, as instructed.

It was encouraging to see that most candidates attempted the final part of the question, even when working in previous parts was muddled and incorrect. Mistakes were often made in the formula for the volume of a pyramid, especially using $\frac{1}{2}$ or $\frac{1}{4}$ instead of $\frac{1}{3}$, or leaving out the coefficient altogether. Errors were also seen in the rearrangement of the equation and the power of x was sometimes lost, but numerous candidates did survive to collect the final mark for an accurate value from a correct solution.

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