Examiners' Report/ Principal Examiner Feedback

Summer 2012

International GCSE
Further Pure Mathematics
(4PM0) Paper 02

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Introduction

Most candidates coped well with the first three questions of this paper but many found question 4 to be very difficult and also had significant problems with parts of all subsequent questions. There was no evidence that candidates did not have sufficient time to work through the paper but there was plenty of evidence that many were inadequately prepared in some of the topics, particularly the differentiation required in question 4, the displacement/velocity/acceleration work in question 9 and the vectors in question10.

Candidates need to be reminded of the need to show sufficient working in case the answer they provide is incorrect. Correct answers obtained from a calculator usually qualify for full marks, but without working being shown, incorrect answers cannot qualify for any marks on that part of a question. It is good practice to quote general formulae before substituting numbers. Incorrect substitution can still lead to some marks being gained as quoting a correct formula and substituting satisfies the general condition of "knowing the method and attempting to apply it" which has to be demonstrated before an M mark can be awarded. This would apply even to basic formulae such as the one for solving quadratic equations.

There are still cases seen where candidates have used a previously obtained rounded answer in a subsequent calculation. Sometimes using, for example, an answer rounded to three significant figures in subsequent working will give the same three significant figure result for a later answer as using the non-rounded value does but frequently it does not. Such cases of premature approximation are always penalised. This can be avoided by initially writing down at least four figures for the first answer and then rounding as instructed; this way the more accurate answer is still available should it be needed later on in the question.

Question 1

Many candidates did well on this question, but there were also many failed attempts. The majority knew they needed to take logs at some stage, though in a number of cases there were attempts at rearranging before taking logs. Successful attempts at this often first moved to $5^x = 24$, then proceeding to $x = \frac{\ln 24}{\ln 5} = 1.97$. Unsuccessful attempts usually revolved around rewriting 120 as $5^3 - 5$ and incorrectly taking logs to lead to $(x+1)\ln 5 = \ln 5^3 - \ln 5$, or similar.

Most successful attempts were by the way envisaged, but there were alternatives. There were a number of cases rewriting 120 as $5^{2.97}$ or $5^{2.98}$ without justification.

Question 2

This was a well attempted question with most candidates scoring full marks. Where marks were lost it was mainly in part (b); the basic differentiation of (a) was well accomplished. In (b) where errors were made it was due to either not knowing the correct method at all, or less commonly the division being the wrong way up.

Question 3

This was the most successfully answered question of the paper, with the majority of candidates scoring full marks. Only a small number used a substitution for *y* instead of the easier one for *x*. In such cases errors were more common.

Errors simplifying to a three term quadratic were made by some candidates, but the method of solving a quadratic was known by almost all. However, there were a few cases where the candidates equated their solutions to *x* instead of *y* after solving the quadratic, and thus lost the last mark for incorrect final values.

Question 4

For part (a), most candidates achieved full marks. Some candidates used the quotient rule to solve the problem a slightly longer method than necessary.

Candidates found part (b) more demanding than part (a) and the most common method seen was the quotient rule. Candidates differentiating 'directly' (ie using the chain rule but with no intermediate working) were more often successful than those attempting the quotient rule.
Part (c) was the most demanding part of the question. There were a variety of approaches which all involved differentiating functions of sine and/or cosine at some stage. A significant number of candidates struggled to differentiate $\left(1-\cos^2 x\right)$ or $\sin^2 x$ correctly. For differentiating $\left(1-\cos^2 x\right)$, $2\sin^2 x$ and $2\cos^2 x\sin^2 x$ were common incorrect outcomes.

Candidates using the chain rule throughout generally met with a good deal of success. Candidates using the quotient rule throughout were often less successful across the whole question. Common errors in attempting the quotient rule were the inability to differentiate 1 and forgetting to square the denominator.

Question 5

Part (a) was another very well answered question. The only exceptions were either occasional (very rare) errors finding the y-coordinates, or slightly more commonly, a few candidates tried finding the stationary points of the two functions rather than the points of intersection.

Part (b) was less well done, but most candidates realised the difference between integrals was needed. It was uncommon to see attempts at building the area up from four integrals, but candidates taking that approach often did well and achieved the correct answer, though a few only used three integrals, or had incorrect limits on their integrals.

There were a few attempts at the sum of the integrals, rather than the difference, and also there were a few cases to watch out for where the two integrals were worked out independently and combined afterwards. In such cases a lot of the time the sum of the integrals was chosen, but in some cases it was correctly put together. Occasional attempts at first making the integrals positive and then taking the difference were seen. But the most successful attempts were when the correct expression of the difference of integrals was first written down.

It is worth noting that the integration itself was generally very accurate, with only occasional slips with powers or multiples.

Question 6

Part (a) was very successful with most students being able to select the values needed to find the ratio. Even though simplification was not requested, many seemed to do this automatically, which made the remaining parts of the question simpler. Part (ii) was equally successful, following on from part (i).

In general, candidates were aware of convergence but did not fully understand the required conditions on the common ratio. Candidates with a correct common ratio usually obtain the correct sum to infinity. Most candidates attempted to use the correct formula.

Many candidates took advantage of their calculators in this question to automatically neaten up expressions. This meant quick progress through both parts whereas candidates working by "hand" took several lines to achieve the same results.

Question 7

Many candidates found the identification of asymptotes difficult although part (a) (ii) was usually answered correctly. The intercepts were usually identified correctly. A small number of candidates did parts (i) and (ii) in (a) and/or (b) the wrong way round.

Whilst most candidates knew how to draw the graphs, the coordinates of the points where the curve crosses the coordinate axes were often not shown on the graph clearly. Many candidates emphasized the coordinates by putting darker dots on the graph but did not write down the coordinates on the graph.

Candidates found the final mark difficult. They knew to solve the equation, but often made slips when substituting into the equation of a line expression. There were a few candidates who got caught up in the question and didn't follow through a complete method. Not too many spotted the quick way of obtaining the correct equation.

Question 8

A significant number of candidates merged y to a single fraction first before differentiating. The most common approach to differentiation was to use the quotient rule. Many made the mistake of differentiating a constant incorrectly, and this seemed to be the only mistake. Candidates seemed well rehearsed on their differentiation rules and quoted them with accuracy. Few candidates used the chain rule method to solve this problem. Candidates achieving a three term quadratic demonstrated the ability to solve it successfully. Almost all candidates achieving the x values substituted to get the y values.

Candidates with a correct (or incorrect) chain rule differentiation in part (a) were left with a challenging task to find the second derivative. As a result, many failed to obtain a fully correct expression although many were 'correct enough' for the first M mark to be awarded. Almost all candidates realised they needed a second derivative and were then able to correctly interpret their results.

Question 9

There were only a few fully correct attempts at this question. The main loss of marks was due to the lack of a constant in the integrals for the displacement, though the velocity was often correctly done in both (a) and (c), perhaps because the need for a non-zero constant was apparent in (a), and so candidates realised the need for it in (c) too.

The use of $v = u + at$ was a very common approach to (a); unfortunately those who used this approach in (a) often used it in (c) as well. Roughly 50% of candidates who attempted the question used integration throughout, while of the others, the next most common approach was to use constant acceleration equations in (a) and (c), but integration in (b) and (d). Only a small proportion (maybe 5%) used $s = ut + \frac{1}{2}at^2$ or another of the uniform acceleration equations in (b) (and (d)).

As already noted, the integrals most often lacked a constant of integration, but the correct answers were attained by many candidates. The most common incorrect solution was $v = 6t^2$ and $s = 2t^3$ as the answers for (c) and (d), with $3t^3$ also being fairly common.

Part (e) was the most successfully attempted part of the question, with many candidates benefiting from the follow through mark. A common answer other than 70m was 195m, resulting from $s = 2t^3$ in (e). Errors in working out the difference were rare, but occasional confusion between the displacement and velocity expressions did occur, especially in part (f).

Question 10

As is typical of the vectors question, this one was not answered well by many candidates. A few fully correct solutions were seen, but the proportion was small. Finding $\overrightarrow{BC}$ did not cause too many problems, but sometimes that is as far as candidates got.

Part (a)(ii) was attempted by most candidates, but not much more than half knew how to proceed. Those who didn't usually tried to find $\overrightarrow{CD}$ and show that was parallel to $\overrightarrow{AB}$, missing the clue in (i). There were also a few attempts which managed to show the vector sum of the four sides of the quadrilateral was 0, and thought this showed it was a trapezium. It is also worth noting that the majority of candidates who did show that $\overrightarrow{BC}$ was parallel to $\overrightarrow{AD}$ also went on to show $\overrightarrow{AB}$ was not parallel to $\overrightarrow{DC}$ thinking that this was an important part of it being a trapezium.

In part (b) there was a lot of confusion as to what was needed in each part, with many candidates stopping at finding $\overrightarrow{BD}$ in (i), and only going on to find $\left|\overrightarrow{BD}\right|$ in (ii), often then stopping without using it to find the required unit vector. There were successful attempts nevertheless, and the correct unit vector was found by some candidates who had only gone as far as $\overrightarrow{BD}$ in (i).

Part (c) was reasonably successfully answered, most by the vector method. Only a handful of candidates used the formula for dividing in a given ratio. Ignoring of subsequent working was employed often in this question, though, as many candidates incorrectly simplified from $3\mathbf{i}+5\mathbf{j}+1/3(6\mathbf{i}-2\mathbf{j})$ to $5\mathbf{i}-13/3\mathbf{j}$.

Part (d) was left out by many candidates, and many more only got as far as writing down $\overrightarrow{EC}$. Only around half made a good attempt. Of those who did attempt it, most common was to find $\overrightarrow{CF}$ (or $\overrightarrow{FC}$). $\overrightarrow{CE}$ was often given as $3\mathbf{i}+5\mathbf{j}$, instead of $\overrightarrow{CE}$. $\overrightarrow{EF}$ was the least common one to find, but whichever were found, once they had been found the candidates did try to show one was a multiple of the other, though the vectors were not always found correctly, and so some candidates came to a halt at that point. There were also attempts by various candidates at finding different vectors entirely, which did not get very far. However, there was a greater degree of success in getting the correct ratio for part (ii).

Coordinate geometry methods were actually very rate, with only a handful seen, both in (a) and (d).

Question 11

Overall, candidates were very good at these skills. *AC* and *EG* were found with few errors. *AP* gave more difficulty with a few using the lengths *PQ* and *AQ* to find *AP*. Again, this should be discouraged in classes. The main errors came from them being asked for a 3sf solution in part (b), but then needing to use at least 4 figures in their value in subsequent parts. This question was completed efficiently and accurately. Pupils set their work out clearly and selected the correct trigonometric ratios to use. There were a few who seemed to simply run out of time as they completed the first few parts of the question easily and then the page became blank.

A lot of candidates lost marks in (a)(iii) by not giving the full method to find *AP* or by not deriving but using *PQ* = 3,an answer given later in the question.

In (d), a large number of candidates were not able to gain the first mark in (i). The most common mistake was using the looping method by using the given answer *PQ* = 3 to find *AP* in part (a), and then using $AP = 3\sqrt{2}$ to find *PQ* = 3 here.

Several candidates attempted to identify the correct angle for part (f) by annotating the diagram rather than using triangle *PQE* which often meant incorrect angles were calculated or,worse, standard trigonometry was used in non-right-angled triangles.

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