Examiners' Report/
Principal Examiner Feedback

June 2011

International GCSE
Further Pure Mathematics (4PM0)
Paper 02

June 2011
Publications Code UG027961

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Specification 4PM0
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Introduction

This seemed to be a well balanced paper, with some challenging questions for the more able candidates and some questions that were accessible to all. This is the first session that this specification has been examined but there were few changes from its predecessor (7362 A/O Pure Mathematics). One significant change was the inclusion of radian measure, as opposed to simply the use of radians for solving equations. The number of poor or blank responses to Q6, which should have been straightforward, suggested that the inclusion of this work had been overlooked by some centres.

Candidates at this level are expected to know that obtaining an answer to a specified degree of accuracy requires working with more figures until the final rounding. In several questions many otherwise good candidates seemed unaware of this and so lost accuracy marks. Some candidates are still throwing away marks by failing to follow rounding instructions included in the questions. Candidates should be advised that marks for one part of a question cannot, in general, be awarded in another part. Thus, for example, a candidate who in Q7(b) obtains the second differential and justifies the minimum cannot have the marks for (c) automatically. If the error is realised in (c), no examiner would insist on the work being repeated, but a comment like "see (b)" or the work in (b) being ringed and labelled (c) will allow the marks to be awarded.

Answers to some questions can be obtained from a calculator without showing any working. However, candidates need to be aware of the danger of not including evidence of their methods; a slight error will lead to an incorrect answer and without working this incorrect answer will score zero.

Report on individual questions

Question 1

Many candidates find the sigma notation challenging. Too many candidates just summed the first 20 terms instead of the required ones. Those who correctly completed the question often used the technique of $\sum_{1}^{20} - \sum_{1}^{5}$ and thereby avoided the problem of the number of terms in the required sum.

Question 2

Most candidates knew that differentiation was required here and then they set their result equal to 12, but, as always with this type of question, a few integrated and consequently scored zero whilst others treated it as a constant velocity question. The preferred method of solving the quadratic equation was by factorising but some used the formula, often incorrectly as they failed to equate three terms to zero first. Most realised that only the positive solution was required and either never showed the negative one or eliminated it by a comment or just crossing it out. Those who gave both answers were penalised by loss of the final accuracy mark.

Question 3

The sine rule was known and applied well in part (a) but many candidates failed to take account of the information that the required angle was obtuse and gave their answer as 45^{o}. This led to problems in part (b) as it resulted in *D* being incorrectly placed between *B* and *C* and only the method mark could then be awarded. Candidates who did obtain the obtuse angle for their answer to (a) often worked with 135^{o} instead of 135.2^{o} in (b) and so lost accuracy.

Question 4

Part (a) was successfully completed by the majority although some careless arithmetic was followed by the correct (given) answer! However, many did not realise that part (a) was intended to assist with part (b) and these candidates used the factor theorem to obtain one or two other factors rather than dividing by $(x+4)$ and factorising the quadratic obtained. A complete factorisation of this cubic needs three linear factors; some lost the final accuracy mark in (b) by omitting to show their factorisation or only showing two factors. Most who were successful in (b) were able to apply their result to obtain the answer for (c). Occasionally candidates did not factorise in (b) but did so to answer (c). Unfortunately they could not retrieve the marks lost in part (b).

Question 5

A variety of methods were seen in part (a). Those who knew the ratio formulae were usually successful in (a) if not in both parts. Some candidates used lengthier vector methods based on their diagrams but often only achieved one correct value in (a) and the corresponding one in (b). Others realised that simple diagrams could be used with the ratio information to write down the answers for both parts without further ado. A reluctance to draw a diagram led many to misplace the point *E* in part (b) so that the point divided *AB* internally in the given ratio.

Question 6

A surprising number appeared to be unaware of the formula for the length of an arc with an angle in radians. Some obtained an angle in degrees and then stopped while others converted their degrees to radians. The question required an answer in radians and so no credit could be given in (a) unless the answer was in the correct units. Those who did covert to radians sometimes lost accuracy for the rest of the question. Parts (b) and (c) could be worked in either angle unit and marks were often gained here without any being gained in (a). Too many candidates used the 6 as a straight edge of a triangle and used various trigonometric techniques with it. In part (b), quite a few found the area of the triangle, but used this correctly in (c) to find the shaded area. As with question 4, marks could not be transferred from one part of the question to another, so these candidates were not awarded the marks for the area of the sector.

Question 7

Candidates seemed to be more successful with part (a) of this question than has been the case in the past and there were fewer 'fudged' solutions seen. Most candidates who had difficulty here either gave up or managed to correct their work. The most common error was to include the top of the box in their calculation. In part (b), differentiating and solving to obtain a value for x was done well by most candidates. The most common reason for loss of marks in (b) was to omit to obtain the minimum value of S. Sometimes this was found in part (c) - but no marks could be awarded here. For part (c) the majority of candidates now use the second derivative test; showing the second derivative is positive is sufficient to justify a minimum, which should be stated. However, the second derivative must also be correct in its algebraic form for the accuracy mark to be awarded.

Question 8

Most candidates knew the formula for the *n*th term of a geometric series and so were able to set up the two equations needed to obtain the two values of the common ratio required by part (a). Many, however, failed to notice that the rest of the question required them to work with a convergent series and so the common ratio used must satisfy $|r| < 1$. The question was worded so that part (a) required two answers but part (b) required only one, so a choice had to be made. Making this choice is part of the method for part (b) and so offering two solutions is not acceptable. Forming an inequality and proceeding to a value of 10.6 in (c) was often successfully achieved by most of the candidates who were working with $r = \frac{1}{2}$. However, achieving all four marks was not as common since many candidates divided their inequality twice by negative numbers without reversing the inequality sign and so lost the final accuracy mark as their solution was not fully correct. Most who obtained 10.6 then rounded up to 11 as n had to be an integer and gained the final mark if everything else was correct. Some spurned the inequality and used an equation. The accuracy marks were only available to these candidates if they completed their work by testing the sums when $n = 10$ and $n = 11$ or making a comment about all the terms being positive so the sum is always increasing and the required value must be 11.

Question 9

On the whole, candidates were good at setting up the expansion using the correct $\pm\frac{3x}{4}$ and power in parts (a) and (b). Some candidates made errors when cancelling the fractions - perhaps they should learn to use the fraction button on the calculator for this job. There were a few cases of candidates writing down the expansions in terms of ${}^{n}C_{r}$s and then using a calculator to obtain the required result. If the expansion is fully correct this is fine, but a minor slip means no working has been shown and so no method mark is available and hence 0/3 is given for that expansion. Part (c) showed that many candidates are still not aware of the condition for validity of a binomial expansion with a negative or fractional power. In part (d), many candidates realised what was needed but made errors in their multiplication. Some candidates left one or both 4s in their answers while others attempted a division. Those who had a series expansion for (d) generally realised they should be integrating it in part (e). In some cases their incorrect expansion in (d) still gave the seemingly correct answer of 0.441 in (e). However, these candidates could not have the final accuracy mark as their solution was based on an incorrect expansion.

Question 10

Most candidates knew that the sum of the roots here was -6 and the product was 2. Those who worked with a sum of 6 were allowed to score 6 out of 8 in parts (a) and (b) but were fully penalised thereafter. Part (i) of (a) was usually correct but many candidates fell down in (a) (ii) as they did not realise that the same algebra applied to $\left(\alpha^2\right)^2+\left(\beta^2\right)^2$ would lead them efficiently to the correct answer. Part (b) saw more successful results. In part (c) only a minority of candidates realised that using the difference of two squares twice would give a complete factorisation; many stopped after only one application and others produced some expression which may have been equivalent to $\alpha^4-\beta^4$ but was certainly not a factorisation of it. A significant number of those who failed to achieve the desired result in (c) still managed to arrive at a correct result in (d), using previously obtained results and hence satisfying the "hence" requirement. Some produced the result for (c) as they worked in (d), but once again, the marks from a previous part could not be retrieved. Only the better candidates realised how to approach (e) to obtain the value of β^4 in an efficient manner. Occasionally candidates obtained an expression for β by using their results for $\alpha+\beta$ and $\alpha-\beta$ and then raising this to the fourth power.

Question 11

The usual problems of completing the square were seen in part (a). Candidates who find this technique difficult would be better advised to expand $(x+A)^2+B$ and equate coefficients instead. Interpreting the results from (a) to obtain the least value of $\mathrm{f}(x)$ and the corresponding value of x as required in (b) was a problem for many, including some who had correct results in (a). The "or otherwise" option included in the question did allow part (b) to be completed by calculus methods instead and this allowed even those who had no values for A and B to gain the marks here. Parts (c) and (d) were generally done well, with some candidates gaining their only marks on this question in these two parts. A significant number of candidates seem unable to establish which way up a quadratic curve should be. It is disappointing at this level to see quadratics that are upside down or have two turning points. Some diagrams were inconsistent with the results obtained in (c) and (d), even when these were correct. In part (e), those who adopted the "$\int \text{line} - \text{curve}$" approach (now included in the specification) were able, in general, to arrive quickly at the correct area. Some attempted to split the area into a trapezium and three separate areas under the curve. Of these, not all included sufficient parts to cover the whole of the area needed and some with all the necessary results then added/subtracted incorrectly. Others simply subtracted $\int_{-6}^{-1}\left(x^2+6x+8\right)\mathrm{d}x$ from the trapezium and thereby achieved the correct result. It was impossible to know whether this was by good luck or good management. Many candidates used the limits the wrong way round and obtained a negative answer. Simply making this positive was not sufficient - stating that the negative was a result of reversing the limits and then changing the sign would have been.

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