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Examiners' Report/ Principal Examiner Feedback

Summer 2014

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

Paper 2

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Principal Examiner's Report

International GCSE Further Pure Mathematics

(Paper 4PM0-02)

Introduction to Paper 02

This paper was found to be more accessible than Paper 1. There was little evidence that students ran out of time before being able to demonstrate their knowledge fully.

Students 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 full 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 a method mark can be awarded. This would apply even to basic formulae such as the one for solving a quadratic equation.
As always there were cases seen where students 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.

In trigonometric questions students are advised to work in the units of the question and let their calculators do the work for them. Working in degrees instead of radians (or vice versa) and then changing units to obtain an answer in the required units not only wastes valuable time, but also increases the chance of errors.

Report on Individual Questions

Question 1

Overall this was well answered with a good number of students able to achieve full marks. Common errors included using degrees and failing to convert to radians and using an incorrect formula usually arc length rather than sector area in part (a). Some students appeared confused between the area of a sector and the area of a triangle.

Question 2

Most students answered this question well, correctly identifying that there are 56 terms in the sequence and either finding S_{56} or $S_{60} - S_4$. However, there were still a significant proportion of students who scored no marks because they failed to grasp the number of terms in the series. There were also a significant number of responses that used 55 terms rather than 56, hence gaining only 2 marks. There were very few blank responses, suggesting students understood what was required.

Question 3

In part (a) most students managed to find a correct expression for $\overrightarrow{OB}$ (a small minority found $\overrightarrow{BO}$). Less able students then had problems such as not knowing the meaning of isosceles, not knowing how to calculate the length of a side and not stating a conclusion. Many students appeared to not know what was meant by a unit vector and so could not gain the mark in part (b).

Question 4

Blank responses for part (a) were very rare. There was a very high success rate for students attempting the question. Students understood what was required and made good attempts to find the correct coordinates. These were almost always in pairs and only a handful stopped after finding the x values.

In part (b) almost all students gave answers involving inequalities with x, 2 and 5. However, many were incorrect, often giving answers with x in the middle of two inequalities. Many of those identifying the correct region lost a mark for expressing the required outside regions in a double-sided inequality. Only a few did not include =. Most students started part (b) by solving again rather than using their answer from part (a). Those who drew sketches were more likely to succeed.

Question 5

Parts (a) and (b) were answered correctly and concisely by the majority of students. However there was more differentiation between the ability of students in part (c). In part (c), most of the students attempted the change of base correctly, but many were unable to deal with the resulting equation. Some confused the laws of logs relating to $\log 64$ often ending up with $\frac{1}{3}\log p$. The most successful students substituted to make a quadratic in x or y. Solving the quadratic posed few problems for those students.

Question 6

The marks on this question were quite polarised. Those who successfully negotiated the algebra in part (a) often went on to gain full marks. Those who did not, scored little more than 2 or 3 marks. Blank responses were uncommon. Students were usually able to recall at least one of the required formulae for part (a) but of those who had both correct, very few realised (or at least did not take advantage of the fact) that $\frac{a}{1-r}$ is present in both S_∞ and S_n. This would have been helpful in part (a) and also in part (c).

The formulae needed in part (a) were generally well known although a sizeable minority only recalled one of them correctly. The best solutions came from using the correct sum formula, the sum to infinity formula and dividing as shown in the mark scheme. Equally successful was using $a + ar + ar^2 = 175$ and substituting $a = 200(1 - r)$. A few arrived at a quartic equation in r, $200r^4 - 200r^3 - 25r + 25 = 0$ and correctly solved to $r = 1$ or $r^3 = 1/8$, although a significant number using this approach made sign errors in rearrangement and therefore did not cancel correctly.

If part (a) was correct then part (b) usually was too. The great majority of students knew what to do in part (c), although a few started using arithmetic series formulae in this part. Sometimes the algebraic manipulation was a bit unwieldy but many successfully arrived at $\left(\frac{1}{2}\right)^n = \frac{1}{256}$. As many students then used inspection of powers of 2 as used logs to complete to $n = 8$. One noteworthy source of error seen in solving for n was $100 \times 0.5^3 = 50^3$.

Question 7

In part (a) most students managed to find the coordinates of the point of intersection with the majority using the first method. Those who used differentiation tended to make mistakes.

The most common error seen in (b) was the failure to establish the correct limits of integration. Many students used 0 and 4 only to find that the result of the integral in the first scheme method was then zero. Another error was to forget that the equation of the curve was in terms of y^2 and to square again before attempting to integrate. There were two problems for those who used the second method – sign errors when taking away the brackets and not realising that the volume of the small cone was needed.

Question 8

Almost all students knew what to do in parts (a), (b) and (c). As with similar questions in previous years, most students found these straightforward and provided consise calculations and well-constructed graphs whereas a small minority had little idea of what was actually being asked and, in particular, had little or no understanding of asymptotes. Part (d) was less accessible. Some students omitted this part, others did not realise that they needed to differentiate. Completely blank responses were very rare.

In part (a) the method for finding asymptotes was generally well known, although there were a surprising number of errors here. Not all gave equations and the asymptotes were sometimes reversed, although students then frequently labelled them successfully on their sketches in part (c). Quite a few students made x the subject in order to find $y = \frac{3}{4}$.

In part (b) the coordinates of the intercepts with the axes were usually correct but occasionally reversed, although less often than with the asymptotes. Most students made a good attempt at the sketch in part (c), and some of the errors in parts (a) and (b) were corrected here. However, many students did not gain the full 3 marks for the graph, sometimes because the asymptotes/crossing points were not labelled, sometimes because the graph had only one branch. The standard of graph sketching was no better or worse than in previous series. Some students take care, others rush; some label everything, others label nothing. Those who attempted the differentiation in part (d) did so very successfully to gain M1A1 and almost all used the quotient rule as in the mark scheme. Only on few occasions were the terms on the numerator reversed. Only a handful of students used the product rule. There were occasional slips in substituting $x = -1$, sometimes in the removal of the brackets in the numerator but more often in the denominator. The B1 for $y = -5$ was usually given as were the next M1A1ft for the equation of the normal but a noticeable minority used an incorrect point (one of the intercepts with the axes). The great majority, having successfully obtained the equation, managed to give the answer in the required form. There were many fully correct solutions here.

Question 9

Parts (a) and (b) were very successfully done by most students. The only issue was the omission of "= 0". However students often realised that this was missing and went back and added it as an afterthought.

For part (c) those students who were familiar with factorising cubics dealt with the question without any issues but a few found the correct factors but did not display all three factors together, thereby failing to complete the demand to "factorise completely".

In part (d) the most common error was to terminate the curve at the points of intersection with the x-axis. Some students drew a negative cubic curve. It was rare to see fully correct solutions for part (e). Many used the wrong limits and some used complicated combinations of integrals of the two functions. A frustrating error was not to give the answer to 3SF, 500/27 was a common answer. Those who were most successful simplified the difference of the two equations before integrating. The limits were usually correct but errors were made when substituting them.

Question 10

The first part of the question on deriving double angle formulae from the addition formulae for sine and cosine was answered well by most students, although there was variation in the length of working produced to support their conclusion. Those who failed to earn marks simply did not show sufficient intermediate steps to justify the given result for cos 2*A*, or failed to change the *B* in the addition formula to an *A*, or used a corrupted version of the Pythagorean identity such as $\cos 2A - \sin 2A = 1$ or $\cos A = 1 - \sin A$. The great majority of students scored all available marks.

Many students successfully proved the identity in part (b) although some failed to use their answers to part (a) and repeated the same work. It was surprising to find a number of students who answered part (a) correctly but then made sin 3*A* = sin *A* + sin 2*A* in part (b), as if the addition formula no longer applied. Missing brackets were also an issue in part (b), but most students recovered successfully in their next line of working. Where students started badly or lost their way subsequently, many tried making small but completely unjustified adjustments to get to the given result.

To solve the equation in part (c) students were required to see the connection with the result from part (b). A good proportion managed this, but there were a handful who arrived at fully correct or nearly fully correct solutions without expressing the equation in terms of sin $3x$. In these cases, many students tried unsuccessfully to factorise the expression while more successful students were able to write down values of sin x directly, presumably through the use of a calculator. A large number of students worked in degrees regardless of the method they used and many lost marks through failure to convert to radians or inaccurate conversion. The smallest value of x seemed particularly susceptible to rounding errors, perhaps as the third significant figure is in the ten thousandths place. Those who were able to work in terms of sin $3x$ in radians from the start were least likely to make these errors. It was very rare to see responses that gained both accuracy marks. For those who got as far as solving and using radians 0.0843 rather than 0.0842 was commonly seen, although 0.963 and 2.18 were usually accurate. The fourth value was often missing or incorrect.

Few students managed to answer parts (d) and (e) correctly – many failed to use their previous result to obtain an expression to be integrated and therefore did not score any marks. Only a small number of students seemed to have a good grasp of integrating trigonometric functions with many trying to apply some version of a rule for integrating powers of x, so that $\cos^4\theta$ appeared regularly but $\sin^2\theta$ and similar were also seen. Those students whose integration strategies were based on increasing powers generally saw no need to use an identity to simplify the integral but even some of those who could see a link with the previous parts of the questions struggled to make the necessary substitution. Many of those who successfully transformed the integral tended to make slips in integration.

Question 11

In part (a) a surprising number of students choose to start with cos 60 = ... rather than using cosine rule in the usual format. Students using the cosine rule were usually successful whichever format they started with. Frequent errors seen included multiplying out the brackets and re-factorising as their 'proof', others misquoted the cosine rule, some did not know where to start and others students incorrectly processed the length of *BC.*

In part (b) the quadratic was almost always solved correctly but the reason for not using $x = \frac{1}{9}$ was rarely correct. Students said that it was inappropriate but did not always spell out why this was so. Most did choose to use $x = 3$ for the remainder of the question.

Part (c) was generally answered well with only a small minority using the wrong combinations of angles and sides. Most used the sine rule but the cosine rule was seen occasionally. A significant minority of students failed to give the answer correct to 1 decimal place.

Some students did not appreciate the significance of 'exact' in part (d), giving the answer as a decimal. Those who used $x = \frac{1}{9}$ should have realised when they obtained a negative area that they should have used $x = 3$.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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