Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International GCSE
In Further Pure Mathematics (4PM1) Paper 02

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Question 1

More mistakes on this question than there should have been for a first question. There were a few who started part (a) stating the surface area of a sphere or the curved surface area of a cone. There were quite a few instances of candidates using the formula in degrees rather than radians which scored them the first mark but lost them the second. Some candidates evaluated the correct answer and then changed to decimals but still received A1 due to isw. A frequent error was the manipulation from $2\theta = \frac{\pi}{2}$ resulting in $\theta = \pi$. Most common mistake in part (b) was seeing $2+2+\frac{\pi}{2} = \frac{9\pi}{2}$. Too many candidates had the correct workings for (b) but ended with a decimal, so not the exact answer that was required. A few of those that ended with 5.56 then decided to approximate that to an answer of 6.

Question 2

In summary, a good number of well answered, fully correct answers were seen. The vast majority worked in terms of *w* compared to length. In most cases candidates who understood the question went on to score full marks with only occasional errors seen, for example: incorrect factorisation of quadratic, arithmetic slips in the solving the linear equation, choosing to use -4 instead of 2 in the final inequality, did not give final answer in terms of *w*. Major problems arose for candidates, preventing them scoring any marks, when they failed to form either expression in terms of *l* or *w*, as they could not get to $l = w + 2$. Or they were unable to create correct expressions for either *P* or *A* even when they had *w* and $w + 2$.

Question 3

Most candidates were familiar with the product rule and many gained full marks.

A number of candidates started this question by trying to differentiate to just one term e.g. $4e^3(2x-1)^3$. For those that did use the product rule to get two terms, a few of them forgot to put the new power on the differentiated bracket, so could not earn the first mark and thus did not score for the whole question. There were a significant number of candidates did not differentiate $(2x-1)^4$ correctly, often seen getting $4(2x-1)^3$ instead of $8(2x-1)^3$. Another less common error was who differentiated $(2x-1)^4$ to $(8x-4)^3$. Many candidates did not show their substitution of $x=1$ and just wrote the decimal equivalent, losing the final mark. A few candidates managed to remove the e^{3x} so their final answer became just 11. Also a few candidates who have substituted 1 to $2x-1$ but not to e^{3x}, ended up losing the last two marks. The alternative way that candidates who expanded the brackets before or after differentiation was only seen a handful of times and was mainly executed correctly.

Question 4

Part (a) tells candidates to give answers to 2dp. There were many instances of 1dp, 3dp and 4dp. The answers to 2dp were not always correct as the right rounding had not been applied. Too many candidates lost marks in part (b) as they could not plot the coordinates for their curve correctly. A relatively common error was plotting $(0.25, -0.55)$ at $(0.25, -0.75)$. Some candidates plotted the points but did not draw a smooth curve to connect them. There were even instances of lines of best fit drawn. The workings for part (c) were usually correct although some could not or did not know how to apply logs. Some managed to multiply $\frac{3x-4}{2}$ by 10 and equate it to $6x-1$. Some had drawn tables of values and picked various *x* values to substitute in. They managed to draw the line as required. Some candidates didn't write in the form $y = kx - 2$ but still found the correct equation and went on to draw the correct line for M3. There were quite a few who drew the correct line after correct workings but never gave their estimate for the root of the equation. The question asked for 1dp, but too many candidates gave their answer as 2.03/04 or 2.05. A few gave the answer as 2, which was not allowed in the mark scheme.

Question 5

This question was generally well done, with most students attempting it and many earning 4 out of the 5 marks. The majority correctly identified $\frac{\mathrm{d}V}{\mathrm{d}h} = 18h^2$ and $\frac{\mathrm{d}V}{\mathrm{d}t} = \pm 36$ with only a few writing $\frac{\mathrm{d}V}{\mathrm{d}t} = -36$. Some candidates who struggled to identify both $\frac{\mathrm{d}V}{\mathrm{d}h}$ and $\frac{\mathrm{d}V}{\mathrm{d}t}$ still managed to earn the third mark by correctly finding $h = 4$. The use of the chain rule was evident, though not all candidates explicitly stated it. Very few candidates scored the final mark. Those who correctly identified $\frac{\mathrm{d}V}{\mathrm{d}t} = -36$ at the start went on the earn full marks by accurately finding $\frac{\mathrm{dh}}{\mathrm{dt}} = -\frac{1}{8}$. Most, if not all the candidates who wrote $\frac{\mathrm{d}V}{\mathrm{d}t} = -36$, failed to recognize that the question referred to a decreasing rate and did not adjust their final solution by either indicating their value should be negative or stating the rate was decreasing.

Question 6

For part (i), the majority of the candidates correctly arrived at the final value of $b = 243$ by employing either the main method or the alternative one presented in the marking scheme. However, some misconceptions were seen in this part mainly stemming from applying incorrect forms of the laws of logs. The common one involved an incorrect product rule where they wrote $\log_b 3 + \log_b 9 = \log_b(3+9)$ instead of $\log_b(3\times 9)$. Even so, candidates had a chance to score the penultimate M mark if they correctly converted their incorrect log equation to an exponential equation. Another error seen was the incorrect step to convert from their log equation $\log_b 3 = \frac{1}{5}$ to an exponential equation that would have concluded the finding of *b* such as for example they found $b = 3^{\frac{1}{5}}$ instead of $3 = b^{\frac{1}{5}}$ that would have led to the correct final value of $b = 3^5$.

Part (ii) of the question was less accessible for some candidates as it needed a change of base of the logs to the same base in order to progress to the next steps of the solution. A good majority of the candidates reached the stage where they formed a quadratic equation to solve and find either $\log_3 x = \frac{1}{3}$, $\log_3 x = 9$ or $\log_x 3 = 3$, $\log_x 3 = \frac{1}{9}$. The ones who did not access the step where the first 5 marks had been collected were stuck either working out the right-hand side of the original equation $8\log_4 128$ and replacing it with 28 or identifying the need to rearrange and form a 3-term quadratic equation. Once the candidates collected the first accuracy mark then almost all of them progressed to finding the exact correct $x = 19683$ or $x = 3^{\frac{1}{3}}$. A few candidates failed to observe that the required values of x had to be exact and lost the last accuracy mark by writing $x = 1.44$ without mentioning the exact form $3^{\frac{1}{3}}$ first.

Question 7

For part (a), a few candidates used algebraic division to show that $(4x-1)$ was a factor of $\mathrm{f}(x)$. This scored M0A0, but they then used that division in part (b).

A number of candidates didn't explicitly state $x = \frac{1}{4}$ in part (b). They just gave the irrational solutions.

Part (c) was generally well answered. A few candidates failed to include =0 at the end, hence lost the final A.

Part (d) was generally well answered, although some included the irrational options too, losing out on B1.

Part (e) was well answered.

Part (f) was the most variable in the question. A number of candidates failed to work with inequalities all together. Some incorrectly expanded the numerator after the first line to get $144 - 36^{n}$, and so missed out on the dM1. Inequality symbols towards the end were very messy, with lots of crossing out. A large number dealt with the logs correctly to get 5.45 but failed to take account of the division by a negative (log0.25) to flip the inequality. This then meant they lost out on A1 at the end.

Question 8

This vectors question proved to be quite accessible for candidates overall. It certainly seemed as though candidates were very familiar with the idea of writing a particular vector in two different ways, using two different unknown constants, comparing coefficients to calculate the values of these constants from a pair of simultaneous equations and then applying these values to produce an unknown vector. Essentially, part (c) was answered extremely well with a vast majority of correct solutions encountered.

Part (a) was likewise answered correctly by most candidates, and it was not uncommon to see full marks scored on parts(a) and (c) with nothing on part b. Perhaps the notion of applying simple trigonometry caught candidates by surprise, expecting something a little more complex as has been the case in recent papers. Of the different methods listed on the scheme for answering part (b), Herons Formula was not commonly encountered but was generally accurately applied by those individuals who chose to go down this path. The first alternative, the method of determinants was seen at quite a few of occasions, again almost exclusively produced the correct solution. Each of the different approaches making use of the cosine rule combined with $\frac{1}{2}ab\sin C$ for the area of the triangle appeared regularly among those candidates who attempted part (b); once again leading to a correct solution more often than not.

The most unusual solution for part (b) only appeared a couple of times. This involved correctly answering part (c) first, and subsequently using the magnitude of this vector solution to calculate the required area in part (b). Answering part b after part (c) also appeared on many other occasions, however, apart from the couple of items referred to above, one of the three main alternatives was the method of choice in these instances.

There were few instances of candidates scoring nothing at all on this question.

Question 9

This was a challenging question although many candidates gained full marks for the first two parts.
In part (a), the main cause of mark loss was not writing $\cos 2\theta = ...$ Rather they wrote $\cos(\theta + \theta)$ as their starting point. A few managed to get to $\cos^2\theta + \sin^2\theta$ before manufacturing the correct given answer. There were also leap of faith answers that quoted $\cos^2\theta - \sin^2\theta$ followed by the required answer without any work to show their steps.

Candidates managed to score well in part (b), although there were those that did not make the required change to $\cos 2\theta$ at the start of their integration and tried to integrate $\cos^2\theta$ to $\sin^2\theta$. Integrating to $-\frac{\sin 2\theta}{2}$ was common as was integrating to $2\sin 2\theta$. Some showed their steps correctly by substituting the limits but forgot to divide by the 2 despite it being in their written work. The other frequent mark lost was writing $-2+\sqrt{3}$ with the minus sign inside the fraction line or sometimes rather ambiguously half outside.
Part (c) proved challenging for many, there were few fully correct answers. Some candidates never tried to equate the two curves and tried integrating with incorrect limits. There were many who equated the two curves but changed the squared term into $\cos 2\theta$, then added the other $\cos\theta$ resulting in $\cos 3\theta = 0$. This mistake was seen also when candidates were trying to find the area, so integrating $\cos 3\theta$ to $\pm\sin 3\theta$. Some candidates did manage to get the correct answer using larger regions and taking away more than one part. Not explicitly substituting in their limits in the integrals meant losing the method mark if the answer was incorrect, although of the candidates who managed to find an expression for the area, many did attempt this, which was good to see.

Question 10

A long question worth 18 marks which again was quite challenging.

Parts (a) and (b) were answered the wrong way round on multiple occasions. The asymptotes were seen in the first part and the intersections seen in the second.

Part (b) asked for an equation, but just the value was given many times or line parallel to *x* axis is $\frac{5}{3}$, parallel to *y* axis is $-\frac{2}{3}$. A lot of the curves managed to bend back on themselves or away from the asymptote, losing the mark. Despite the request for labels, these were sometimes omitted which lost marks.

Part (c) proved too much for some candidates and there were several papers had this part left blank may be due to lack of time. The differentiation was usually completed correctly, where it was attempted, although a few sign errors were seen leading to 4 as the numerator rather than 16. Some tried to equate this with $\frac{(x+7)}{4}$ rather than $\frac{1}{4}$ and some had already noted the normal gradient of -4 and equated their differential to this. Most lost marks as they hadn't found that $y=1$, after successfully finding $x=2$, so struggled to find the equation of the normal and hence correct coordinates for intersections with the axis. There were quite a few responses were seen where they went from $4y-x=7$ to find their *D* and *E* coordinates, setting *x* and *y* equal to zero and using those coordinates correctly to find the length of a line. A few candidates made sign errors whilst finding the equation of their normal resulting in the normal being $y=-4x+7$. The resulting *D* and *E* values and length of the line still gained them marks. There were follow through marks for the points *D* and *E* and nearly all candidates who attempted the length of *DE* gained the mark for correctly calculating the distance using their coordinates.

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