Examiners' Report

Principal Examiner Feedback

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In Further Pure Mathematics (4PM0) Paper 01

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There was much good work seen throughout both these papers although it was clear that weaker students found these papers considerably more difficult than last January's papers. In paper 2 there was evidence that some students ran out of time as a significant part of question 10 was not attempted by otherwise strong students.

Students need to ensure they both read and abide by the demands of the questions. Some did not round answers as requested, others failed to change equations so that the coefficients are integers and in question 1 of paper 2 did not write the coefficients of the points of intersection of the lines with the coordinate axes on their sketches. Students should also note the instruction on the front of the paper that "without sufficient working, correct answers may be awarded no marks". This is particularly important in "show that" questions. When the answer is shown on the paper students must ensure that every step, however trivial, is written down.

Paper 1

Question 1

There were many errors in remembering the correct formulae for the length of an arc and the area of a sector. Those students who chose to use the formula $A = \frac{1}{2}rl$ made even more errors. Students should know how to derive these straightforward formulae and then there would be no need to rely on memory. For example, length of arc $= \frac{\theta}{2\pi} \times 2\pi r \Rightarrow l = \theta r$.

As is usual in any question involving radians, some students try to work in degrees (even though there is more work involved) and then make rounding errors. Responses which gave working in degrees and were correct gained full credit, but the angle was required in radians so answer in degrees received no credit. No indication was given in the question for the accuracy required for the radius, which should imply to students that the value is likely to be exact. The question explicitly asked for the **exact** value of θ, yet so many students lost the final mark by giving an answer of 4.04 radians without showing $\frac{18}{14}\pi$ or $\frac{9}{7}\pi$ first.

Some students made very hard work of eliminating either r or θ when it was really quite a simple manipulation.

Question 2

(a) There were many complete correct answers given here with virtually every student knowing how to apply factor theorem correctly.

(b) Fewer students were able to link the remainder theorem to the demand to find the remainder when f (x) was divided by $(x+2)$. Most students completed this part of the question by division and did so accurately and fluently. Substituting −2 into f (x) was however, easier and quicker.

(c) It was fairly obvious that $(x+1)$ was a factor of f (x) once the given value of p was substituted so quite a few students divided f (x) by $(x+1)$ instead of the obvious choice of the given factor $(x-4)$, and as in part (b), did so accurately. Several students thought that $(x+2)$ was a factor despite having found a remainder in part (b).

In order to earn the method mark here, a complete method was required and so it was necessary to factorise the quotient. Quite a few students completed the division only and did no further work resulting in no marks in this part.

(d) The question was constructed so that students should merely set their factorised function = 0 , and write down the values of the three roots. It was fairly obvious that a few students were using graphic calculators to find the roots instead of using algebra particularly in no work was offered in part (c). Mark schemes in these questions always specify that answers must come from correct algebra so no marks were available to those who just wrote down answers without evidence of a factorised function seen.

Question 3

Virtually every student found the critical values of $\frac{1}{3}$ and 3. Despite this question asking for the inside region which is easier to specify, there were still errors in specifying the correct inequality. A simple sketch of the quadratic nearly always resulted in success for full marks.

Too many students continue to write $3x^2-10x+3<0 \Rightarrow x<\frac{1}{3}, x<3$.

For those students who just cancelled through by $(3x-1)$ and gave the solution $x-1<2 \Rightarrow x<3$ there were no marks at all.

Question 4

(a) Most students completed this part using substitution instead of division, resulting is very large numbers and equations in r^4 or r^3, although quite a few of these attempts were eventually successful. Instead of adding or subtracting the equations to find t_2 and t_5 and then either replacing these with ar and ar^4, many filled both pages with $a\left(r \pm r^4\right)$ and even then did not simplify numbers but carried on working with values of $\frac{11340}{6156}$ which actually simplifies to $\frac{35}{19}$. Virtually every student found the value of a correctly.

Despite the question specifying clearly the series was geometric, a few students thought it was arithmetic.

(b) Most students knew the formula for the sum of a geometric series to infinity and so there were many correct final answer of $S_\infty = \frac{6}{5}$

Question 5

For such a straightforward question in trigonometry, there were relatively very few full correct answers. This arises from a lack of attention to detail when reading the question. Moreover, rounding is penalised in this specification and if an accuracy of 1 decimal place, or 3 significant figures is required, then students should give answers round correctly as required.

(a) Students were told that *AB* = *BC* and the diagram was marked accordingly. Even so, some students failed to recognise that triangle *ABC* was isosceles.
Most used the easier sine rule very successfully to find a correct expression for length *AB*. However, only a few students read the question carefully which specified an exact length, and a surprisingly small minority actually gave the answer as $4\sqrt{3}$. Most gave the answer as 6.928 thus losing one mark needlessly.

(b) In triangle *ADC* only sine rule was able to be used, and so it was successfully by the majority of students, only once again many did not read the question which stated that the required angle *ADC* was obtuse. Most left the answer as 59.4° again losing a mark.

(c) The result of leaving angle *ACD* as 59.4° resulted in an erroneous angle *ACD* which most students used to find the area of triangle *ADC,* thus losing a further two marks. Whilst it is true that diagrams are not drawn accurately, and this is clearly indicated in examination papers, they are neither drawn so wildly incorrect that angle *ACD* could conceivably be an angle of 85.6°, which was by far the most popular angle used to find the area of triangle *ACD*. The final correct area of 40.6 was a rare sight.

<u>Question 6</u>

This topic is difficult to many students who simply have no concept of finding asymptotes and find discontinuous curves difficult to deal with.

(a) The instruction ‘write down’ means that students should be able to write down the required values without calculation, but just by inspection of the function. In this case, given that the denominator was $(x+a)$ and that the equation of the vertical asymptote was $x = -2$, then a must equal 2.
The equation of the horizontal asymptote was $y = 3$, and because the coefficient of x in the denominator was 1, and the coefficient of and the coefficient of y in the numerator was b, then the value of b could only be 3.

(b) This part could be answered correctly without a correct value for *b* and we allowed for this in the mark scheme. Many students simply did not know that all that was required was to substitute in the values (3.5, 0) into the equation and solve for *c*.

(c) We allowed a full follow through for the A mark using students values for *b* and *c* in this part, but as in (b) only a small minority actually knew what to do.

Question 7

(a) Most students managed to find the three missing values correctly, although there were errors in rounding which suggests not reading the question or carelessness.

(b) Again, most students were able to draw their graphs successfully and accurately. There were some very strange shapes in a few cases. Students at this level of mathematics are expected to know the general shape of a logarithmic curve, and to be able to instantly assess whether their coordinates when plotted are feasible.

(c) and (d) There were many students who did not attempt these two parts but those who did knew exactly what to do. A common error in both parts was to draw the straight line correctly, but then forget to write down the *x* values at the points of intersection.

Some students in part (d) took logarithms correctly but identified the line requires as either $y=\frac{1}{3}x-1$ or $y=3x-1$.

A common error seen in many scripts for part (d) was $x=0.5$ which is the point of intersection of $y=x+2$ and $y=3x+1$.

Question 8

(a) (i) Many students found the expansion correctly.

(ii) Quite a few students did not attempt this part, although in the main, those who did were able to write the range of values of *x* correctly.

(b) Although many students found *B* correctly, very few indeed realised that they must take out 2^{-3} from the bracket, and the most common answer for *A* was 2.

(c) Responses in this part fell into two categories; those who realised that work in parts (a) and (b) should be used and part (c) and those who did not. Many of the latter tried start again to expand $\left(2+x\right)^{-3}$ and then try to divide $\left(1+4x\right)$ by their expansion. Those students who did know that that they were continuing using the same expansion frequently forgot to multiply their expansions from (a) by their *A* as well as $\left(1+4x\right)$ thus gaining no marks here.

(d) The majority knew the correct method of integration and substitution of limits, but had the incorrect expansion at this stage. However, the two method marks were available for correct work on their expansions of $\frac{\left(1+4x\right)}{\left(2+x\right)^{-3}}$.

Question 9

This was a straightforward question and in general was answered well throughout.

(a) Virtually every student found the correct sum and product of the quadratic equation.

(b) Many students were able to write down a correct expansion for $\alpha^3+\beta^3$ but there was the inevitable fudging to make their expansions fit the given value, the most popular incorrect algebra being $\alpha^3+\beta^3=(\alpha+\beta)^3-4\alpha\beta \Rightarrow \alpha^3+\beta^3=-\frac{152}{27}$

(c) The sum and product of the roots were straightforward to find for virtually all students, although the most commonly seen error for the sum was $\frac{\alpha^3+\beta^3}{\alpha^2+\beta^2}$.

(d) Quite a few students either left their (correct) equations in fraction form as $x^2+\frac{38}{27}x+\frac{1}{2}=0$ or missed = 0, so leaving their answer as (y =) $54x^2+76x+27$.

Question 10

This was a straightforward question in kinematics and it was rare to see an error in parts (a) and (b). It was very clear that this cohort of students knew exactly how to approach this type of question.

Quite a few students lost marks in (c) by forgetting to add the initial displacement of 3 m and so an answer of $s=\frac{16}{3}$ was seen very often.

Question 11

(a) (i) Many students wrote down only one equation connecting p and q, usually $3p+9q=9$, and used the given value of p to get q. Only the most able students were able to interpret the question correctly regarding the information about the stationary point and use it correctly. Not many students at all achieved full marks in this part. Virtually every student was able to find the value of q correctly.

(ii) Many did not attempt this part at all, even if the rest of part (a) was correct. The simplest method was to find the second derivative and substitute p = 6 giving a value of $\frac{d^2y}{dx^2}=-2$.

Some students chose to complete the square which was an equally acceptable method, showing that the coefficient of the bracket was negative, hence a maximum.

(b) This part was mostly well answered even if it was the only part of the question attempted.

(c) The final correct volume of $\frac{333}{5}\pi$ was very pleasing to see though it was rare, since even with a fully correct method there was ample opportunity for algebraic and numerical slips. The main stumbling blocks were as follows:

- Students were not squaring y's,
- Forgetting that π was required in the formula,

- Considering only curve *C* or line *l*.
- Not knowing how to find the volume of a truncated cone,
- Squaring the difference rather than subtracting the squares.
- Thinking that the limits for integration were $x = 0$ and 6 which are the intersections of the curve and the x axis.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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