Examiners’ Report
Principal Examiner Feedback

Summer 2017

Pearson Edexcel Advanced Extension Award
In Mathematics (9801/01)

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Introduction

The paper was accessible to all students and the overall performance was higher than last year. Questions 3, 5 and the last part of 7 were generally answered very well but question 4 proved more challenging. Fully correct solutions to 2(b), 6 and 7(b) were also fairly rare.

Comments on individual questions

Question 1

This proved to be a good starter. In part (a) most could find a correct form for f^{-1} but the domain caused some difficulties. Some just thought it was the same as f(x) and others, possibly confused by the square root gave $|x| \geqslant \sqrt{2}$ Those who knew what was going on in part (b) either completed the square or differentiated to find the minimum and were then able to write down the range quite easily but there were a number who simply thought the answer was g(x) $\geqslant$ 5. Part (c) caused few problems and almost everyone solved the equation correctly.

Question 2

There were 3 simple trigonometric facts needed to establish the result in part (a) and most students were able to complete this successfully, though not always in the most direct manner. Part (b) proved more discriminating. Most spotted the $x = 20^{\circ}$ solution but then one of the other two solutions was invariably missing. There were also some incorrect values frequently given: $x = 160^{\circ}$ from 180° – 20° and 40° from mishandling the equation $2x = 180 - (60 - x)$. Some students used the factor formulae to get $\cos\left(\frac{x}{2} + 30^{\circ}\right)\sin\left(\frac{3x}{2} - 30^{\circ}\right) = 0$ and they were generally more successful in finding all 3 solutions.

Question 3

Part (a) was answered very well and most found the correct value of p and the correct position vector for the point B. In part (b) most used a general point C and formed the vector $\overrightarrow{AC}$. Some had an expression in 3 variables and they were rarely able to form an equation in one variable which they could solve. Most though found an expression in terms of t but many then took a scalar product with $\overrightarrow{BC}$, rather than the direction vector of the line L_1, and this gave them a quadratic equation in t. Solving this quadratic equation sometimes proved tricky as the coefficients were not especially friendly but many ploughed on to find the position vector of C correctly. Those who had a linear equation in t had a much easier route to the answer and also stood a chance of securing an S mark for this question. There were a variety of approaches adopted in part (c). Finding the length of AC, the length of BC and using the simple property of an isosceles triangle was used by some but others chose more round-about routes. Some used scalar products to find the cosine of an angle, then found the sine and then used the $0.5ab\sin C$ formula whilst others chose to find the position vector of D, often from another quadratic equation based on *AD=AB*, and then used *AC* and *BD* to find the area. Despite the preponderance of inefficient methods there were a good number of students who obtained a fully correct solution in a succinct manner and secured the A mark here.

Question 4

Part (a) was answered well and the majority obtained both marks here. In part (b) some assumed that the minimum length of *PQ* was obtained when *PQ* was perpendicular to *LM* but most used the cosine rule to form an expression in x and y for PQ^2. Most of the successful attempts then used calculus to establish the minimum of $x^2+\left(\frac{2}{x}\right)^2-2$ but some used $(x-y)^2+4-2$ to successfully establish that the minimum value of *PQ* was $\sqrt{2}$ occurring when $x = y$. Convincing arguments based on symmetry were only seen occasionally. Part (c) was a mystery for many students and was often not attempted. Those who did tackle part (c) usually arranged the 6 copies of the triangle to form a hexagon, centre *L*, and then drew a circle inside the hexagon centred at *L*. They were then invariably able to complete the calculations for the minimum arc length *PQ* but the final mark for a full justification was rarely awarded.

Question 5

Virtually everyone scored the first 2 marks in part (a) and many went on to gain most of the marks for the sketches that followed. In (b)(i) a mark was often lost for omitting the point (0 , – 6) or for having this intersection with the y-axis above the horizontal asymptote. The other difficulty here was finding the correct points of intersection with the x-axis. Forming the correct equation proved difficult: some simply solved f(x) = 4 and others went wrong when forming f(x + 2) and we often saw $\frac{4(x+2-1)}{x(x+2-3)}=4$ being used. In (b)(ii) there was the usual confusion between f(|x|) and |f(x)| with many graphs having 3 intersections with the positive x axis. Some were still able to find the correct intersections with the x-axis but seemed unperturbed when these didn't match their sketch.

Question 6

Part (a) appeared to unsettle some students. Most started by using the chain rule but some could not utilise the algebraic skills necessary to successfully simplify their answer to arrive at the given result. A few students familiar with hyperbolic functions used that approach but those who simply quoted formulae from the formula booklet failed to “show” the required result and gained no marks. In part (b) most knew how to use the substitution but a surprising minority had expressions for $\frac{dx}{dt}$ in terms of ln$t$. A good number arrived at $-\int\frac{1}{\sqrt{t^2+2t}}\,dt$ but could not see the connection with part (a). Those who did realise they needed to complete the square and then use part (a) often found a correct integral but this was rarely given as an expression in *x* and the final mark was lost. Part (c) was invariably completed correctly and often provided a suitable hint for students to tackle part (d). Most realised they could split the integrand and many were able to integrate the $\left(2x+7\right)^{-\frac{3}{2}}$ term correctly and usually show some clear use of the limits. Slips in arithmetic and dropped minus signs abounded but there were plenty of students who arrived at the correct answer here, sometimes after changing the limits to use their answer from part (b) which was still in terms of *t*.

Question 7

In part (a) the quality of the explanations was rarely good enough to secure both marks. Most realised that the left hand side (LHS) came from equating the equation of *C* to the equation of *L* but few could explain satisfactorily why there were only two roots and these were both repeated roots. Why, for example, could the right hand side (RHS) not be $\left(x-p\right)\left(x-q\right)^3$? Part (b) was the part that proved the most discriminating. A few missed the instruction to integrate by parts and started to get into a mess by integrating the LHS which, unfortunately, would not bring them to the required answer. Most could start by integrating the RHS by parts but some then tried multiplying out and others never explained why the integrated term was zero. The superiority of the $\int_p^q u\ \mathrm{d}v = \left[uv\right]_p^q - \int_p^q v\ \mathrm{d}u$ approach over the $\int_p^q u\ \mathrm{d}v = \left[uv - \int v\ \mathrm{d}u\right]_p^q$ approach became very clear as some students tried to keep all 3 terms in their working before finally substituting the limits and greatly increased the risk of a sign or arithmetic slip. Many though were able to integrate parts correctly again and arrive at the given answer, hopefully also appreciating the relative simplicity of this approach to finding the area of *R*. Part (c) was answered very well with most multiplying out $\left(x^2-2px+p^2\right)\left(x^2-2qx+q^2\right)$ which was probably easier than $\left(x^2-(p+q)x+pq\right)^2$. Most realised that equating coefficients of powers of *x* was the way forward in part (d) and this was accurately done with many reaching correct values for *p* and *q* and realising that $q > p$. There were occasionally slips when finding the equation of *L*; some missed the minus sign and had $c = p^2q^2$ and some forgot to write down a proper equation in terms of *y* and *x*.

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