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# Mark Scheme (Results)

# June 2011

## AEA Mathematics (9801)

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# Advanced Extension Award Mathematics Specification 9801

## Introduction

There were plenty of accessible parts to most questions and virtually all the candidates were able to get started on most questions with questions 2, 3(a), 4(a), 5(a)(b), 6(b)(c) and 7(a) being answered well. The paper also gave plenty of opportunities for the better candidates to shine and questions 1, 5(c), 6(a) and 7(c) proved to be quite discriminating. The work on calculus was generally answered well whilst questions involving trigonometry, vectors and functions proved more challenging.

**Report on individual questions**

**Question 1**

Most candidates launched into the tan($A$ + $B$) formulae and, sometimes two pages later, rarely made any progress. Some did convert to sines and cosines but the temptation to expand their terms was often too great and collecting terms to identify a cos($A$ + $B$) expression eluded most. A few candidates realised that cot$x$ = tan(90 – $x$) and were then able to obtain one or both answers in a couple of lines but this property of these trigonometric functions was clearly not familiar to many candidates.

**Question 2**

This was probably the best answered question on the paper with many giving a fully correct and concise solution. Most multiplied out the brackets and they usually knew how to convert $\tan^2\theta$ into $\sec^2\theta$ although sometimes this did take several steps. The integration was often correct as far as the functions were concerned but a number of candidates failed to give the correct multiples with $2\ln\sec\left(\frac{x}{2}\right)$ being a common error. The limits were usually applied correctly although a few had trouble evaluating $\ln\sec\left(\frac{\pi}{4}\right)$. There were only a handful of candidates who tried integrating $\tan^2\theta$ as $\dfrac{\tan^3\theta}{3}$ or $\dfrac{\tan^3\theta}{\sec^2\theta}$ suggesting that perhaps they were not yet ready for this paper.

**Question 3**

Part (a) was usually answered correctly but some failed to give a convincing argument in part (b). Most successful attempts realised that the series could be split into 2 geometric series and then used the sum formula twice to reach the printed answer. Others paired up the terms to identify a geometric series with first term $k(1 + p)$ and they were then able to reach the required result quite easily. Candidates should be aware that a "show that" question will require some explanation and candidates jumping from their list of 6 terms straight to the printed answer did not receive any credit. Part (c) proved impenetrable to some who simply omitted this part and others failed to read the definition of $[x]$ for which some credit was given. Those who carefully wrote out the first few terms of the series were soon able to identify the link with the previous part and then complete the question. Only the most thorough students explained why the $(pq)^n$ term tended to zero to gain both S marks here. Statements such as $\left(\frac{4}{5}\right)^{\infty} = 0$ were not regarded as "good style".

**Question 4**

The most common approach to part (a) was to eliminate $t$ and obtain an equation of the form $x^2 + y^2 = x$. Most then went on to complete the square and find the centre and radius. Part (b) caused few problems and most knew that they then needed to differentiate but some found $\frac{\mathrm{d}y}{\mathrm{d}\alpha}$ instead of $\frac{\mathrm{d}A}{\mathrm{d}\alpha}$, where $a$ is the area of $R$. The product rule was nearly always used correctly and candidates could usually identify $\alpha = \frac{\pi}{6}$ and find the corresponding area but many failed to explain how they knew this was a maximum value, full calculation of the second derivative was not essential as an argument based on the cosine = 0 case giving a minimum would have been sufficient.

**Question 5**

Parts (a) and (b) were answered well and many were able to establish the printed result although sometimes there was some poor work on the way: gradient of normal in terms of $x$ not $a$ being quite common.

Part (c)(i) many candidates ignored all reference to the circle $E$ and simply tried the task of showing that the LHS of the printed result could be multiplied out to give the RHS. Those who were able to identify the centre of $E$ and the radius of $E$ and hence show the given result were often joined by a number of other candidates who started to solve the given equation and successfully reached the printed result in part (ii). Solving for $a^2$ was then relatively straightforward and the centre and radius of $E$ followed quite naturally provided the connection with part (b) had been made.

## Question 6

Efficient vector methods were rarely used here although a number of candidates did eventually manage some parts of this question with some very laborious techniques. Many made a promising start to part (a) by forming a vector expression in terms of $t$ for a vector from $P$ to $L$. Forming a correct scalar product and solving for $t$ was the next challenge and many stumbled here. The final stage required a strategy for reaching $P'$ and few were able to complete this and obtain $\overrightarrow{\boldsymbol{OP'}}$. Many attempts started with a general point $(x, y, z)$ for $P'$, found a correct scalar product but then they needed to find suitable equations for $x$, $y$ and $z$ in terms of $t$ or somehow find 2 more equations for $x$, $y$ and $z$ . Approaches using $t$ were sometimes successful but those based on $\left|\overrightarrow{AP}\right| = \left|\overrightarrow{AP'}\right|$ often were not.

Part (b) offered a welcome mark to most candidates but some forgot to show that $t = 4$ worked for all 3 components. Most used the scalar product in part (c) but there was general disregard for the direction of the vectors used and many lost the final mark for failing to correctly prove the given result. Most were able to find the areas of suitable triangles in part (d), although some assumed the angle at $P$ was a right angle which they hadn't yet established, and many established that $AB = 10\sqrt{2}$ but the step from here to the position vector of $B$ often proved to be quite difficult: few realised that if $A$ was the point with $t = 4$ and the midpoint of $PP'$ was the point with $t = 3.5$ then consideration of multiples of $\begin{vmatrix} -5 \\ 3 \\ 4 \end{vmatrix}$ would quickly lead to $t = 2$. The final two parts were only attempted by those with considerable fluency in vector methods or considerable stamina. Those who had a correct position vector for $B$ usually picked up the marks quite easily although few mentioned the angle in a semi-circle theorem to justify the centre of the circle being at the mid-point of $AB$.

## Question 7

Part (a) was answered successfully by almost all the candidates. Many realised in part (b) that a horizontal translation of 3 units had taken place and were able to write down $p = 3$ and often the $x$-coordinate of $D$ as 2. Finding $q$ was more difficult but a number were able to form a suitable equation either from the $y$-coordinates of $A$ and $B$ or using suitable values of $x$ in Figure 5.

Part (c) provided a discriminating end to the paper. A number of candidates made good progress in (i) but selection of the correct sign when using the quadratic formula defeated most. Part (ii) was often answered well and many were able to form a correct equation in (iii) but few were able to solve the equation they had formed. Some did seem to be aware of the fact that $\mathrm{m}(x)$ and $\mathrm{m}^{-1}(x)$ will intersect on the line $y = x$ and therefore a simple equation can be formed from $\mathrm{m}(x) = x$ and this approach often led to the correct answer but other equations usually proved too cumbersome for the candidates to solve.

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