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Advanced Extension Awards 9801

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Examiners' Report

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Advanced Extension Awards

Specification 9801

(Maximum mark: 75)
(Mean mark: ; Standard deviation:)

Introduction

The candidature for this paper was mixed. As in previous years, many of the candidates were not prepared for a paper of this type and their performance was disappointing. Most of the questions this year had some relatively easy parts, amounting to about 30 marks in total, so there were relatively few who scored less than 25 marks, and the mean mark for the paper was higher than in 2004. However the number achieving the Merit level was very disappointing. The better of the candidates displayed some very good work and those gaining a Distinction showed a good grasp of the mathematical techniques involved and an ability to develop logical arguments, carry through extended pieces of algebra and work persistently to complete questions.

The six "S" marks available were for the highest S marks obtained on the best three questions. Question 2 had just one S mark available (for a fully correct solution earning all 8 marks). Questions 3 to 7 each had up to 2 S marks. Regrettably these marks were awarded infrequently as complete, efficient solutions to whole questions were all too rare.

Question 1

Most were able to determine the centre and radius of the circle. This was an easy start for those who used the geometry of the situation to arrive quickly at the two required values. A more long-winded method seen quite often was to use the fact that the relevant diameter is $y = -4x/3$ and to then eliminate either x or y from the equation of the circle to obtain a quadratic, from which the coordinates of the two relevant points were found. Pythagoras was then used to find the two lengths. Method marks were only gained for this approach for a complete method.

Many other candidates read the "greatest and least" and immediately resorted to differentiation. They usually obtained $\mathrm{d}y/\mathrm{d}x = -(6 - 2x)/(2y + 8)$ but were then unable to make any progress to answering the question. Some equated the derivative to zero and found the points (3,-11) and (3,3) which were of no help. This approach gained no method marks until a complete method was found (not surprisingly - very rarely).

Question 2

Nearly all gained the first 2 marks for an equation in $\cos\theta$ and $\sin\theta$. A surprisingly large number of candidates "cancelled" the $\cos\theta$ factor and consequently lost two solutions. A reasonable number put $\cos\theta + \sin\theta$ in the form $\sqrt{2}\sin(\theta + \frac{\pi}{4})$ or $\sqrt{2}\cos(\theta - \frac{\pi}{4})$. However of those who chose the cos form, one of the solutions was often missed (arising from the $-\frac{\pi}{6}$ root).

The majority of candidates squared their equation and most often derived $\sin 2\theta = ½$. This usually resulted in 4 values for 2θ and hence also for θ. However it was very rare indeed for any candidate to then check their solutions to reject the two spurious "solutions" which arose from squaring. It is disappointing at this level to find that candidates were unaware that this is necessary. Other attempts at squaring the equation resulted in a quadratic equation in any of the trig ratios, e.g. $\tan^2\theta - 4\tan\theta + 1 = 0$. The solutions of all these equations result in surds, so these candidates received some credit but were unable to complete the solutions.

Question 3

This apparently innocuous question was generally very badly answered. Relatively few candidates attempted to differentiate $u\sqrt{x}$ at the first step and consequently made no progress at all. Of those who did form a correct initial equation, many used inelegant algebra in removing the ½ and $\sqrt{x}$ terms. Those who reached $\mathrm{d}u/\mathrm{d}x(1-2x) = \mathrm{u}$, were often able to make reasonable further progress. Most separated the variables and integrated successfully. Many then made heavy weather of finding the constant of integration, because of the ln terms involved. Some seemed unable to cope with the logs at all.

A minority used an integrating factor approach, often determining the correct factor, but then seemed unable to use it to form $u\sqrt{(1-2x)} = k$. The weaker candidates appeared to be unfamiliar with how to solve a simple differential equation. Surprisingly many attempted to use the boundary condition at far too early a stage, even before attempting any integration.

The given fact that $0 < x < ½$ was totally ignored by almost all the candidates. However most worked with $\ln(1-2x)$ rather than $\ln(2x-1)$ so had no difficulty with the boundary condition.

Question 4

Virtually all candidates gained the 2 marks for part (a). Most correctly differentiated their expression. More success was achieved by considering $\tan p - 1/p$ (or equivalent) and the sign of the function at $\frac{\pi}{4}$ and 1, than by attempting to compare values of $\tan p$ with $1/p$. Candidates often gave a clear reason for the sign of their function for one value but few did so for the second value. Surprisingly many did not give a reason (change of sign in the interval) to justify the given inequality. Communication skills were poor in part (b) and lacked decisiveness (essential to gain the S marks).

Those who obtained $\tan\alpha = \frac{1}{\alpha}$ were often able to find the expression for S in part (c) either by drawing a right angled triangle or from (sometimes lengthy) trigonometry. Hardly any of the candidates gave a complete answer to part (d). Few appreciated that a function may take a maximum or minimum value at points other than the end points of the interval. A proof that S is an increasing function in the interval was required. Consequently candidates scored at most 1 of the 3 available marks on this part, and two S marks were not earned for the question.

Question 5

This was a good source of marks for most of the candidates. Answers to parts (a), (b), (c) and (f) resulted in all 9 marks for many. In part (d) some candidates found $\angle COA$ (without realising it). Where students did lose marks in these early parts, it was usually for not expressing the equation as a vector equation in (a) ($\mathbf{r}$ = ….) and not checking that all three equations matched the values of λ and μ in (c). In part (d) many obtained vector AC and had the correct method using the scalar product for the cosine of the angle. However numerous arithmetic slips often resulted in an incorrect value for cos $\angle OCA$. Some candidates successfully used the cosine rule on the triangle.

Part (e) caused problems for many. Long methods involving considerable algebra were seen. Some assumed that ΔOCA was right angled. Others used cos $\angle OCA$ rather than sine. The only searching part of the question was part (g). Few candidates drew a diagram to show the relative position of the points and hardly any realised that part (f) was only there to try to help with (g). There was an almost complete failure to deal with the geometry of the situation. It was very common to see the assumption that the bisector passed through the midpoint of OA. Many students did not attempt (g) at all. This question was a good source of marks (typically at least 12) but the poor performance on part (g) again meant that few S marks were awarded on this question.

Question 6

There were many pleasing answers to this question. Many candidates obtained high marks on it. Part (a) was an easy source of 4 marks. The sketch in (b)(i) was often correct but (ii) was more challenging. Frequently candidates drew a curve which was symmetric about x= -1. A slip made by several who had the correct shape was to state the negative x-intercept as $-2\sqrt{3} - 1$ (rather than +1). Nevertheless many candidates gained 1 of the 3 available marks here.

The answers to (c) were extremely varied. There were many elegant solutions based on deductions about the horizontal and vertical shifts of the significant points in the figure. Those who made use of the original minimum point made good progress in finding w and v, as did those who solved f(x) = 16 to identify the point (-4,16) on f. However many other candidates used a largely algebraic approach and often got lost in a sea of algebra. Of those who did find w and v, many resorted to algebra to write g(x) as a cubic. This was factorised by using (x-2) as a known factor, resulting in the correct values of 2 and 8. Very few candidates used a symmetry argument on the important points of the figures for f and g to write down the root 8 without recourse to algebra. It was pleasing that a significant proportion of the candidates obtained all 9 marks for (c). Some also gained at least 1 S mark in this question.

Question 7

This question proved hard for the majority. Part (a) was routine enough for most and usually scored the 3 marks. There were mixed responses to (b). The most successful came from either $\int \tan\theta \, \mathrm{d}(\sec\theta)$ or from $\int \sec\theta(\sec^2\theta - 1)\mathrm{d}\theta$. Some used $\int \sec\theta(\tan^2\theta \, d\theta)$ and managed to deal with the slightly more difficult algebra/calculus. Others however were able to make no valid progress from $\int \tan^2\theta \, (\sec\theta \, d\theta)$.

Part (c) proved to be very difficult. Many correctly replaced $\cos 2\theta$ by $2\cos^2\theta - 1$. Others unfortunately tried $1 - 2\sin^2\theta$ which resulted in no further progress. The single step substitution $\sqrt{2}\cos x = \sec\theta$ was spotted by very few. However there were some good attempts at a double substitution, e.g. $v=\cos x$ followed by $\sqrt{2}v = \sec\theta$. Those who were able to carry out appropriate substitutions were in a position to use the result from (b). Some candidates made good attempts at the change of limits of integration under their various transformations. Only the very best were able to obtain the value of the integral, so again S marks were few and far between on this question.