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Introduction

The paper was attempted by candidates showing a wide range of ability, from those who struggled to gather marks on demands targeted at D grade to others who provided clear and concise solutions to all questions. The combination of logarithms with arithmetic series caused some difficulty in question 5 and the solution of trigonometric equations defeated many in question 7. Success in question 9 was often limited to part (a), especially for candidates who were unable to produce a diagram to assist them with the interpretation of the question. Correct solutions were common for the first two questions and full marks were often awarded for question 8.

Most candidates presented their work well and wrote down sufficient working. Answers were nearly always given to the specified degree of accuracy.

Question 1

There were a few attempts to solve each side of the inequality separately but most candidates expanded the brackets and collected terms to give a single quadratic inequality. Very few solutions made use of the common factor $(x - 4)$. Critical values were normally found successfully and there was an improvement in the number of candidates giving a correct range, often using sketches or trial values to assist them. The most common mistake was to proceed from $(x - 4)(2x - 1) < 0$ to $x - 4 < 0$ and $2x - 1 < 0$.

Question 2

This question was answered very well. Nearly all candidates recognised the need to use the cosine rule; a few of them mixed up the sides or made mistakes with the calculation. Most gave the angle correctly to 1 decimal place. The area formula with two sides and the included angle was also used efficiently, though some candidates preferred to calculate an altitude and work with ½ x base x height.

Question 3

Most candidates were familiar with the binomial expansion. Some worked out each coefficient; others stated them, sometimes showing Pascal's triangle. The terms were usually correct. Just occasionally the constant term was missing or the powers of x were matched with the wrong coefficients. There were some answers that showed only the first three or four terms, as if it were the start of an infinite series.

The substitution was normally correct, though the negative sign was not always included. Simplification discriminated well, providing an even split between those who could not find either part of the answer, those who found the rational part, and those who scored both accuracy marks. Attempts to give a decimal approximation were not rewarded.

Question 4

It was encouraging to see a widespread understanding of the theory required for this question. Correct values were usually given for the sum and the product of roots. The most common mistakes were failing to divide by 2 and giving a negative value for the sum of roots. There were some good attempts to add and multiply roots of the new equation, though the detail was not always accurate and substitutions were sometimes wrong. Simplifying the roots to $\frac{3}{\alpha}$ and $\frac{3}{\beta}$ provided a very concise way of evaluating the sum and product of these roots. The results obtained were used well to form a new equation but coefficients were not always given as integers and the three terms were not always put equal to zero.

Question 5

The *r*th term of *S* caused some difficulty. Candidates rarely looked at the pattern 2, 4, 8, 16, … to write down the required term. They were more likely to find the common difference and apply the general formula for the *r*th term, but other lengthy methods were tried, which were often incorrect. Some results were given in terms of *n* rather than *r* and the expression $\log_a 2r$ left doubt about the intended meaning, $\log_a(2r)$ or $(\log_a 2)r$.

The common difference was usually found correctly by subtracting two consecutive terms and this was used well to derive the given expression for S_n. Candidates who attempted the final part usually started by writing down an expression for T_n. This was often guessed as $\frac{1}{2}n(n+1)\log_a 6$ whilst others obtained this result by assuming that the common difference was $\log_a 6$. It was not uncommon to see T_n interpreted as the *n*th term of *T*, despite the clear definition given, and S_n used for the sum of the first *n* terms of *T*. Those who found a correct expression for T_n usually went on to earn a second mark for subtracting S_n and attempting to simplify but few were able to achieve an accurate final result.

The question revealed a common misunderstanding that $\log a - \log b = \log(a - b)$.

Question 6

There was some confusion between degrees and radians in part (a) but correct formulae were usually given for the area of the sector and the area of triangle *OPQ*. Most candidates combined these successfully to achieve the given expression for the area of the segment.

Those who were familiar with the theory for part (b) gave concise solutions, sometimes marred by poor notation. It was not unusual to see *r* treated as a variable with attempts to differentiate using the product rule. Many candidates approached the question from first principles, often losing their way at the first stage. Some did find an expression equivalent to $\delta A = \frac{1}{2}r^2(\theta + \delta\theta - \sin(\theta + \delta\theta)) - \frac{1}{2}r^2(\theta - \sin\theta)$ and the more persistent of these expanded $\sin(\theta + \delta\theta)$ but very few made small angle approximations to complete the method and score the first mark.

Difficulty with part (b) deterred some candidates from attempting to find an estimate for θ but many accepted the given result and made correct substitutions. Mistakes were not uncommon in rearranging the equation to find a value for $\cos\theta$ but there were also plenty of accurate answers. A common mistake was to give a value in degrees. A significant number of candidates ignored the expression that was given for δA and tried to construct another method, which was invariably wrong. The most common of these was to go back to part (a) and write $A + 0.05 = \frac{1}{2} \times 4^2(\theta + 0.02 - \sin(\theta + 0.02))$.

Question 7

Nearly all candidates made the correct substitution in part (a) and exact values for cos45° and sin45° usually followed, with just a few giving decimal approximations instead. The value of *N* was often stated as a positive value but this was not penalised after a fully correct expression.

Few attempts to solve the equation in part (b) made use of the identity established in part (a). Those who followed this intended route made good progress, though x = 180° tended to be overlooked. It was much more likely to see double angles expanded, but mistakes were made and sin2x was often left as a double angle or treated as $\sin^2 x$. This approach frequently led to $2\cos x(\cos x - \sin x) = 2$, which was rarely followed by useful working. Those who obtained $2\sin x\cos x + 2\sin^2 x = 0$ were more likely to complete the solution, but roots were regularly lost by dividing this equation by sin$x$. Another common approach was to square both sides. This was neat but few candidates realised that the procedure introduced unwanted roots. Many other methods were attempted, most of which were wrong. The root x = 0° appeared frequently from incorrect working, which received no credit.

The identity from part (a) provided a small minority of candidates with a quick method to find the value of *k*. They also made good progress in part (d), though some failed to give a positive value for their answer. Other attempts had the right idea but found $k = \frac{1}{\sqrt{2}}$ and there were plenty of guesses that gave *k* = 1. The most popular approach was to differentiate. Mistakes were frequent, both in the differentiation and subsequent algebra, so this procedure rarely produced correct answers to either of the last two parts.

Question 8

Nearly every candidate gained the first mark and went on to apply the remainder theorem correctly, with just a few matching the substitutions of $x = 1$ and $x = -1$ with the wrong remainders. Some mistakes were made solving the simultaneous equations, usually losing a sign to give $b = 3$ or $b = 9$ or dropping a factor of 2 to give $b = 6$ or $b = -6$, but accuracy was generally good.

The factor theorem was also used well. A few attempts failed to realise that one of the equations from part (a) was also needed but most candidates proceeded to find values for *a* and *c*. The final factorisation was completed very well providing that correct values had been found for all of the coefficients. Method marks were still available to those who had made mistakes but their unhelpful values frequently prevented a meaningful attempt to factorise.

Long division was used periodically throughout this question. Mistakes in the extensive working were frequent so correct answers were seldom obtained in this way.

Question 9

The majority of candidates completed part (a) correctly but there were some who failed to differentiate, usually extracting $\frac{1}{4}$ from the equation of *C* to use as their gradient. A few of those who did differentiate went on to use $\frac{1}{2}x$ as their gradient, creating non-linear equations for the tangent and the normal.

The introduction to part (b) caused much confusion. Those who were able to construct an appropriate diagram tended to make some further progress; most others did not. Few were able to reason that, because *QR* is perpendicular to *PR*, it must have a gradient of 2. Attempts were more likely to solve the two equations found in part (a), which made the point *Q* coincide with *P*. Solving the tangent from part (a) with the equation for *C* had the same effect and this made the rest of the question meaningless. Those who solved the normal at *P* with the equation for *C* found the coordinates of *Q* to be (-6, 9).

The minority of candidates who found correct coordinates for *Q* frequently went on to complete the question successfully. Others struggled to collect the method marks available for trying to find the normal and tangent at *Q* and for trying to solve appropriate pairs of equations to find the *x*-coordinate of *R* and the *x*-coordinate of *S*. Good diagrams certainly helped. It was also beneficial, both to candidates and markers, when working was clearly labelled to show which line was intended by each equation. Explanations for the final mark tended to be vague and were obviously dependent on having the correct *x*-coordinate for points *R* and *S*.

Question 10

There were many correct equations for the line *l*. Apart from numerical errors, the main mistakes were finding the equation of *AC* or finding the equation of a perpendicular line through the point *A*. Pythagoras' theorem was used well to find the length of *AC*. As in other parts, some candidates lost the accuracy mark by giving the length as a decimal value rather than an exact surd.

Concise and correct answers for *BM* were frequent though extra halves crept in to some solutions to give $BM = 2\sqrt{34}$. Some candidates ignored their value for the length of *AC* and started again, usually finding the length of *AM*. Others embarked on much longer methods aimed at finding the coordinates of *B*, but these were rarely followed through to an accurate conclusion.

Many candidates found the length of *AB* correctly, though some attempts muddled answers from previous parts. Finding the two possible positions of the point *B* was a greater challenge which was often not attempted and rarely completed. The usual approach was to form equations from $AB^2 = 51$ and $BM^2 = 34$, either of which gained a mark. These were subtracted to give a linear equation, which should have been the same as in part (a) but mistakes tended to obscure this point. Efforts frequently stopped here but the more persistent candidates did gain a second mark by trying to use their linear equation to create a quadratic in either *x* or *y*. Correct coordinates for both positions of *B* were seldom seen. A significant minority used the method of expanding a determinant using the coordinates of *A*, *B* and *C* to give the area of triangle *ABC*. Mistakes were frequent but some correct linear equations were obtained in this way. Those who realised that this needed to be solved with the equation from part (a) usually managed to find one position for the point *B*, which gained three marks, but candidates were unable to adapt the approach to give a method that could generate a complete solution.

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