Examiners’ Report
Principal Examiner Feedback

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Introduction

I had been anticipating that candidates would find the first few problems to their liking before getting their teeth into some interesting yet challenging problems later in the paper. It was interesting to see that even the initial questions tested a large number of candidates. Overall, the quality of solutions appeared to mirror those from previous examination series. The presentation of solutions was mostly very good although some candidates do not seem to want to turn over a page where plenty of space can be found to continue their solutions. There were a small number of candidates who turned back a page in order to continue their solutions and centres would do well to impress upon their charges not to do this, but if it is necessary to do so, make use of supplementary sheets for the purpose of continuing a solution to a problem. Centres should also encourage candidates to read the questions carefully so that rounding errors are not penalized, show all working out particularly when using their calculators (solving quadratic equations), include conclusions for any 'proof' or 'show that' problem. Care should be taken over all curve sketching; axes, asymptotes and intercepts need to be labelled appropriately with curves not bending back on themselves.

Question 1

This question ought to have been accessible to the majority of candidates, however, this appeared not to be the case for many.

Few candidates gained the full 5 marks for this question. Many were able to write an identity for tan x in terms of sin x and cos x, but by some distance the most common next step was to divide through by sin x instead of factorising the expression, so losing the solutions relating to sin x = 0, leaving the candidate with a maximum of 3 marks out of the 5. For those that did factorise, most were able to gain all 5 marks, although it was common to lose the 360 degree solution to sin x = 0 due to not understanding the range required for solutions while a small number of candidates found the value of x = 30 and did not proceed any further.

Question 2

An accessible problem for most, this question was answered well by the vast majority of the candidates. Part a was answered correctly by the majority of candidates, with only the occasional slip in the direction of the inequality. In part b, almost every candidate realised the need for and were able to find the critical values for the function. Many were able to identify the correct region using those critical values even if the solution was not given as a single inequality. However, it was not uncommon to see the two outside regions being suggested. Part c appeared to be the most challenging of the three parts of this problem - most of those with parts a and b correct were able to follow up with part c. However, very few were able to follow through incorrect answers even if the mark was available due to an existing overlap of regions within the solution.

Question 3

What might have been expected to be a straightforward surd problem was evidently anything but for many candidates; for those persistent few who slogged forward blindly, time was easily wasted here. There was an even spread across the two main approaches to this question. Many saw this as an exercise requiring rationalising the denominator, but these candidates often quickly became bogged down in simplifying the algebra.

Using this main method as given in the scheme, candidates usually multiplied correctly to make the denominator into an integer and usually multiplied the two surd expressions in the numerator to get a correct, unsimplified numerator. However relatively few candidates scored full marks from this approach with few progressing beyond their initial moves. There was no clear majority between candidates who expanded and got no further, candidates who formed two simultaneous equations but got no further and candidates who solved their simultaneous equations before being stopped in their tracks.

However, the alternative method was more successful and less long winded. In fact there were some elegant and efficient solutions. The first method mark was simple to achieve (in comparison with main method) and it was subsequently easier to work with a horizontal equation rather than one containing two algebraic fractions. The multiplication for the second method mark was also less complex. Candidates' approach for the final 3 marks differed a little. There were three main approaches seen:

As per the mark scheme

- $c(a + b\sqrt{5}) = A + B\sqrt{5}$ then deduces correct values
- $ca + cb\sqrt{5} = A + B\sqrt{5}$ then deduces correct values

One other alternative approach that was seen by those individuals following the main scheme involved equating the coefficients by including c, rather than producing a pair of simultaneous equations in a and b: for example $(6a+10b)/16=9/c$ and $(2a+6b)/16=4/c$. next divide the 2 equations to arrive at $a/b=7/3$ after some basic algebraic manipulation, deducing from here that $a=7$ and $b=3$.

Those who were unsuccessful in using the alternative method often correctly cross-multiplied but could not proceed beyond the expression $14 + 6\sqrt{5}$. They were unable to recognise that factorisation should be the next step and, as a result, could not deduce the values of a, b, and c.

Question 4

An easily accessible problem in general, this was mostly well answered, with a majority of students gaining at least four marks. A sizable number of candidates failed to acknowledge that r should be a negative value (even though this was given) although this usually did not prevent a correct value for a being identified.

Part (b) was often not answered with sufficient detail, even though understanding was clearly present. Many students omitted the modulus sign, while others focused only on the ratio being greater than 1, often due to an incorrect value for the ratio.

Question 5

Although it was possible to solve this question using the sine rule or the cosine rule, only those that used the cosine rule were able to make serious progress in this question. For those using the sine rule, many were able to get a mark for giving a correct numerical value for sin A, but almost every candidate then used that value to find an approximate value for A, which wasn't able to be recovered to an exact solution.

Those who were able to adopt the unusual application of the cosine rule usually quickly discovered the 3-term quadratic required and were able to come to the correct solution.

Those who scored full marks in part a usually found little problem getting full marks in part b. The most common error here was a failure to keep answers exact throughout.

Question 6

This problem appeared to mirror similar questions that have appeared in recent years. Some candidates clearly are uncomfortable handling formulae connecting surface areas and volumes of spheres, cylinders, cones and cuboids; this was evident once again here.

In part (a), the majority of candidates were able to obtain the correct expression for the surface area of the cylinder and equate it to 700π. A small number of candidates occasionally omitted the area of the base of the cylinder or incorrectly used the surface area of a sphere or cone. Most candidates subsequently manipulated the equation to express either h or rh in terms of r, and substituted this into the volume formula for a cylinder to derive the required result that was given.

However, a number of candidates, who were unable to complete part (a) successfully, did manage to attempt or complete part (b) making use of the given result for Volume. In part (b), many candidates gave correct responses at least as far as finding the value for r that gave a max/min volume. The majority were able to find dV/dr, equate this to 0 and solve for a value for r. Many candidates found the correct value of 10.8 but it was not uncommon to see an exact surd value offered for r even though the question stipulated a rounded decimal value was required. The majority of candidates proceeded to find a second derivative and correctly deduced that the negative value implied a maximum. However, a sizable number of individuals lost this final accuracy mark either because a conclusion was not offered or because they had not given r as a decimal value.

Weaker candidates struggled to differentiate V correctly or solve the resulting equation or did not understand the condition for a maximum volume.

In part (c), candidates who completed parts (a) and (b) successfully were usually able to substitute their value for r to find the corresponding value of h, obtaining h = 21.6. A few candidates mistakenly calculated the maximum value of V instead.

It was interesting to note that some candidates who could handle the calculus were unfamiliar with the geometry of a cylinder-while others understood the geometry well but struggled with the calculus.

Question 7

Using graphs, linear and non-linear, to solve a problem is often where we see blank scripts once the initial drawing of the curve has been completed. Once again this was evident in this question.

In part a, almost all candidates completed the table of values accurately. A very small number made rounding errors for one or more of the missing vales required.

In part b, almost all candidates plotted their points accurately and joined them with a smooth curve. A very small number missed a point by more than the allowed tolerance and therefore did not gain the marks.

As ever the meat of these problems comes after the fairly straightforward drawing of the curve. Part c was answered less accurately while a good many candidates did not attempt it at all (this is often the case with these problems).

Manipulating logarithms successfully, required here, is often what separates the most able individuals from the remainder. The failure to Introduce logarithms in base 3 meant that many were halted in their tracks at this stage. The power law step was also missed out by many unsuccessful candidates. The most common issue among unsuccessful candidates was not handling the division by 3 and addition of 3 in the correct order or even at the most appropriate stage in their solution.

Candidates should be encouraged to read questions carefully for specific instructions, as more than expected gave their final answer to 2 decimal places (possibly from calculator use) despite the question asking for a different level of accuracy.

Question 8

It is often the case that vectors problems pose some of the greatest challenges for a majority of candidates and this was much in evidence again with this problem. Basic vector work is usually handled well but as soon as a degree of complexity is introduced, only the most competent appear to produce accurate solutions. These observations were evident throughout the responses to this question.

In part a, most candidates were successful, as this was basic vector work. The (few) errors seen included **AB = OA + OB**, -(3u + v) not processed correctly, usually with incorrect vector arithmetic. In part b, again, this was well attempted (though less so than part a) with most showing mastery of the processes and scoring full marks. Relatively 'common' errors included using **AB** rather than **AC** or not using k**AC**, incorrect values following correct coefficients of u and v.

Part c differentiated between the very able candidates and the others. Very few full attempts and very, very few full marks awarded; a large number of no attempts. Candidates that made significant progress often scored full marks. Partial progress was occasionally seen with the first two or three marks being awarded but progress not made towards the final solution.

Question 9

In part a, the majority of candidates were able to recall and use the product rule to obtain the correct derivative and proceed to show the given result. The most common error was differentiating incorrectly, often leading to sign errors. The algebraic skills required were generally handled well, though - as expected - candidates occasionally had to rely on some degree of improvisation to complete the proof.

In part b, the majority of candidates correctly proceeded to find the second derivative, with many simplifying this accurately. The most common approach here was to substitute their expressions for dy/dt and y into a form of the equation, and then collect like terms, equating coefficients leading to two equation yielding $M = 8$ and $N = 20$. There were many fully successful attempts using this method, although errors in the differentiation and in collecting like terms generally led to incorrect values for M and N.

Some candidates preferred to replace terms in their second derivative using expressions for y and dy/dt, applying the result from (a) to obtain an equation from which $M = 8$ and $N = 20$ were deduced. Others derived the second derivative in its simplest form and, by inspection, compared the coefficients in the resulting differential equation. For example, they reasoned $M = 8$ and $N = 20$.

Generally, all three approaches led to many fully correct answers. However, errors in the first or second derivatives, sign errors in arithmetic, or comparing incorrect expressions resulted in credit being lost.

Question 10

Often in questions involving curve sketching that require asymptotes, little is attempted by a large number of candidates, beyond the point where the curve is sketched. This was again evident in the attempts at this question. It was not uncommon to see marks awarded for parts a, b and c and little or nothing else attempted.

In part a, the vast majority attempted this with partial, or complete success. Incorrect solutions often gave the asymptote equations correctly but in wrong order. Many candidates lost the first two marks of question either by not knowing the difference between the equation of the asymptote parallel to the y-axis and asymptote parallel to the x-axis, or not writing their responses as an equation i.e. x = and y = .

Part b was generally more successful though it was common to see $x=0$ $y = 7/3$ $y = 0$ $x = 7$ rather than solutions given as two coordinate pairs. On occasion, the value 7/3 followed by 2.3 was offered but most candidates gave the correct fraction before a rounded decimal. Very few just gave a rounded decimal, 2.3 recurring was never seen.

Part c was generally attempted well providing there were correct answers in a and b. Most indicated x and y intercepts and almost always 2 intercepts only. Common errors were curve bending away from asymptotes, curves not being drawn passing through one or both intercepts with the axes and asymptotes not being labelled with an equation.

In part d, most candidates showed good differentiation skills; the quotient rule being the most common approach. A significant minority differentiated and just stated -17/16 without showing the substitution $x = ½$

and subsequent working out. Correct differentiation often resulted in full marks being awarded and helped to distinguish between mid-level and higher achievers. Many candidates appeared to be under the impression that they were working out the gradient of a chord.

Part e separated those at the top end of the ability range. A significant number of candidates did very little or nothing in terms of an attempt and scored 0/7. Many candidates found the equation of a straight line through (0.5, 13/8) with gradient -17/16. A reasonable number of candidates believed that the normal to the curve was what was required and subsequently wrote down gradient equal to 16/17 and proceeded to find an equation of a straight line. Candidates who knew what to do solved for x, some using the equation (2x+3)^2 = 16. Others expanded and achieved a correct 3TQ. Algebra was strong from the candidates that made such progress. Often candidates reaching a value for x = -7/2 would go on to achieve full credit. Candidates calculating c from y = mx + c did this well and often arrived at a correct value for c, a correct equation and a correct equation in the required form even though this is a less direct method than $y - y_1 = m(x - x_1)$. The majority of candidates who reached the stage of finding an appropriate equation used the y = mx + c approach.

A preferred approach seen to find x=-7/2 was to write 2x+3=+/-4 hence avoiding forming the 3TQ equation and use more complex algebraic manipulation. A small number of individuals recognized the symmetry of the curve and were able to deduce the value of x = -7/2 for point P, work out the correct y coordinate and proceed to a correct equation for the tangent.

Some candidates (although very few) missed out on the last accuracy mark by failing to arrange their correct equation of the tangent at P in the required form ax+by+c=0 with a, b, c integers.

Question 11

Part a was found to be very challenging by many of the candidates, with most of the attempts apparently just playing around with double angle formulae and remembered trigonometric identities. Those well acquainted with the difference of two squares, however, were able to get to the correct answer with minimal effort. However, the most common approach was the alternative method that required a considerable amount of careful algebra to multiply brackets using sin^2 x = 1 - cos^2 x - many were able to do this, but sign errors and arithmetic slips were common.

A sizeable number of the candidates were able to spot the connection between the result in part a and make use of it in part b, but many struggled to manipulate the algebra to arrive at a solvable equation. It was common to lose the -3 in their attempts, and so, fail to produce a three term quadratic, whereas many others didn’t spot the quadratic at all and tried, without any success, to divide through by a trigonometric term. Those who were able to form a correct 3 term quadratic, however, were usually able to solve this successfully and arrive at two correct values. Using these to find all of the correct angles, in radians, produced a variety of responses, some more correct than others. Having successfully navigated the problem this far, to lose the final accuracy mark through giving final answers to an inappropriate degree of accuracy was plain carelessness.

Although part c was often left blank, those who attempted it often found it a straightforward question. Many candidates did realise the need to use the identity given in part a, although some reduced the expression to cos 2x rather than cos 4x. From there, a majority of candidates were able to integrate correctly and substitute limits appropriately to gain the correct answer in the required form; a small number as ever losing this final mark if their solution was not presented as requested.

It is often difficult to assess whether or not candidates' unsuccessful attempts at the final question of the paper can be attributed to their running short of time or a genuine lack of understanding and know-how. Some candidates clearly had little idea what was required of them in this part of the question, simply proceeding simply to attempt to integrate what was in front of them and of course making no headway at all. Blank attempts could be interpreted as running out of time and it was not uncommon for candidates to get no marks from parts a and b, and gain full marks in part c.

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