STEP Examiner's Report 2013

Mathematics

STEP 9465/9470/9475

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STEP 2 2013 Examiners' report

All questions were attempted by a significant number of candidates, with questions 1 to 3 and 7 the most popular. The Pure questions were more popular than both the Mechanics and the Probability and Statistics questions, with only question 8 receiving a particularly low number of attempts within the Pure questions and only question 11 receiving a particularly high number of attempts.

1.   This was the most popular of all of the questions. Overall part (i) of this question was well answered, although there were a number of candidates who were not able to find the tangent and intercept even in this first case. Very few attempts at part (ii) of this question involved the use of sketches. While many attempts at part (iii) recognised the link in the final part with part (ii) of the question, many of the explanations in this section were not well enough explained to gain full marks. In the final part it was pleasing to note that many candidates realised that the conditions implied that the intersection with the y-axis was at a negative value.

2.   This was the second most popular question on the paper and the average score was half of the marks. Despite the instruction in the first part of the question to use a substitution a significant number of candidates chose to use integration by parts to establish the result. There were some sign errors in the integrations, but most candidates managed to reach the final result in the first part of the question. The second part of the question was found to be the hardest, with induction the most popular method, although the process was often not fully explained. The final part of the question did not appear to be too problematic for those that reached it. However, algebraic mistakes, such as factors disappearing, resulted in some marks being lost. Similarly, mistakes in the arithmetic in the final part of the question were not uncommon.

3.   This question was again popular and had an average score of about half of the marks. In the first part almost all candidates were able to sketch the correct shape of graph, but some did not provide suitable explanations to accompany these or included additional cases that were not asked for. A number of candidates attempting the second part of the question reached one of the results by squaring an inequality without considering the signs and many assumed that the result of part (i) implied that c must be negative. Only about half of the candidates attempted part (iii), and many of those who did did not use sketches in their solutions. Solutions to part (iv) generally involved guessing of the values of a, b and c followed by a check that the conditions were met.

4.   This question received a relatively small number of attempts compared to the other Pure Mathematics questions. On average candidates who attempted this question only received a quarter of the marks available. Some candidates did not manage to write down the correct equation of the line or did not appreciate that the phrase "unit radius" means that the radius is 1. Many candidates produced loci for the second part of the question without any indication of a method. In the final part of the question the significance of the restrictions on the value of b were not appreciated by many of the candidates.

5.   This was one of the more successfully attempted questions on the paper and the Pure Mathematics question with the highest average mark. While some candidates struggled with the application of the chain rule throughout this question, many were able to complete the first part of the question without much difficulty. Showing that f satisfied the required conditions in part (i) was generally well done, but the sketching of the graph was found to be more difficult, with a number of

candidates not identifying the asymptotes and some thinking that part of the graph would drop below the x-axis. Most of the candidates who attempted part (iii) found the roots of the equation successfully, but a large number forgot to exclude the roots when solving the inequality. In the final part, many identified x=3 as a solution, but those who split the fraction into two equations (one for the numerator equalling 343 and one for the denominator equalling 36) did not check that the solution worked for both parts. Those who used the symmetries established in part (i) were then able to identify the other roots easily, while those who attempted algebraic solutions for the other roots were generally not successful.

6.   The algebra required for the first part of the question proved to be quite challenging for a number of candidates, but most were able to reach the required answer. The proof by induction in the second part of the question was generally well done, although a number of candidates did not write up the process clearly. In the final part of the question it was clear that many candidates had identified the relationship between the sequences and Fibonacci numbers and some candidates therefore stated that the limit would be the golden ratio, but without any supporting calculations. In the final part there were few responses which clearly explained that the new sequence would still satisfy the conditions required if it were started at a later term.

7.   This question was attempted by a large number of candidates, only slightly fewer than question 2, and was one of the more successful ones with an average score above half of the marks. While some candidates proved the converse of the required result, part (i) of the question was generally done well, although a surprising number of candidates did not write down the numerical solutions when asked. Those students who realised the way to write x and y in terms of m and n reached the result of part (ii) easily, while others sometimes spent a lot of effort on this making little or no progress. In part (iii) many candidates spotted the difference of two squares, but some did not realise that there would be two ways to factorise b^3. Only very few students were able to solve the final part of the question.

8.   Candidates attempting question 8 generally received either a very low or a very high score. Many attempts did not progress further than an attempt to sketch the graph and identify the rectangle to be used. There were also some attempts that confused the line $y = f(t)$ with a transformation of the curve $y = f(x)$. In the second part of the question there were some difficulties with the differentiation of $g(t)$, but those candidates who successfully completed this section did not in general have any difficulties with the remainder of the question.

9.   The average score on this question was below a quarter of the marks as a large number of attempts did not make progress beyond the first few steps of the solution, achieving just the marks for the resolution of forces required in the first part of the question. Many candidates forgot some of the forces involved and very few decided to take moments. Some of the more clever solutions took moments about one of the contact points, which removes the need for one of the steps resolving forces.

10.   This was the least popular of the Mechanics questions. The first part of the question was generally well answered and many candidates were able to apply the result of part (i) to the particular case identified in part(ii). Part (iii) was found to be more challenging, but some candidates did manage to provide a convincing argument for their answer.

11.   This was the most popular of the Mechanics questions and also the most successfully answered question on the paper with candidates scoring on average three quarters of the marks. Candidates appeared to be very comfortable with the concepts of conservation of momentum and the law of restitution and were able to progress through the series of calculations required without too much difficulty. There were some errors in the algebra, but the majority of candidates were able to work through accurately to the end of the question.

12.   This was the least popular of all the questions. Many of those who did attempt the question succeeded in calculating the expressions for the expectations, but the simplification of the calculation for the variance proved more tricky. A good number of the candidates managed to reach the final part of the question, but few were able to provide a valid argument for the final result.

13.   Many candidates were able to complete the parts of the question that related to the early cases, but some struggled to generalise the expressions for the probabilities in the cases required in part (iii) of the question. Of those that reached the correct expressions many struggled to establish the required relationships between them.