STEP III 2016 REPORT

General Comments

A substantially larger number of candidates took the paper this year: 14% more than in 2015. However, the mean score was virtually identical to that in 2015. Five questions were very popular, with two being attempted by in excess of 90% of the candidates, but once again, all questions were attempted by significant numbers, with only one dipping under 10% attempting it, and every question was answered perfectly by at least one candidate. Most candidates kept to six sensible attempts, although some did several more scoring weakly overall, except in six outstanding cases that earned very high marks.

Comments on individual questions

Question 1
This was the most frequently attempted question with more than 93% of candidates attempting it. It was also successfully attempted, the second most in this respect and only by a small margin, earning two thirds marks on average. The majority of candidates completed parts (i) and (iii) with little trouble, with various algebraic mistakes occurring throughout, and a few candidates forgetting to substitute for the limits in part (i). Many got started on part (ii) using the substitution from part (i), and then get stuck faced with the consequent integral.

Question 2
This question was quite popular, being attempted by just over three-quarters of the candidates, but success was moderate. Most got underway differentiating implicitly, rather than parametrically, and were able to find equations of tangents, normal and chords, but not always simplifying by factorising to make their lives easier; those who could factorise made good progress, whilst those who did not struggled to find (i). Other weaknesses were not appreciating that they could find $r+q$ and rq, which then led to not finding the certain point in (ii). In the final part, square rooting the inequality and only considering the positive case was not uncommon.

Question 3
Marginally less popular than question 2, this was very slightly better attempted. In both parts, candidates successfully equated the differential of the expressions on the right of the equations to the expression to be integrated, with the exponential function cancelled. In the first part, many obtained $P(x)$ in the given case of $Q(x)$, but the attempted proofs that the degree of $P(x)$ is one more than that of $Q(x)$ and for part (ii) that no such polynomials exist led to many illogical steps. Many would have benefited by multiplying up by denominators and using the remainder/factor theorem, rather than attempting arguments based on degrees of rational expressions. Some subverted part (i) by successfully integrating the first expression.

Question 4
Very slightly more popular than question 2 with four fifths attempting it, they did so with slightly less success. The first part of the question, being well signposted, was pretty well attempted, although there was some very poor notation for limit arguments as N was commonly taken to equal infinity. In part (ii), it was quite common for candidates to write the expression for sech(ry) in terms of positive powers of exponentials which made attempts to apply (i) invalid. Few candidates fully simplified the final result, and prior to that, many did not handle the positive and negative parts of the sum correctly with some just doubling the sum from 1 to infinity.

Question 5
This was attempted by half the candidature, scoring similarly to question 2. The binomial expansion and its symmetry were well-handled in the first part, as was applying the result of (iii) in part (iv). Part (ii) was not well-answered as there tended to be cavalier statements regarding divisibility, and in part (iii), few noticed that the condition $\mathrm{m} + 1 \leq 2\mathrm{m}$ was required in order to use (ii).

Question 6
Just under 40% attempted this question, and did so without great success, scoring about one-third marks. The majority knew the formula for cosh of a sum, or if not, could use definitions and compare coefficients to obtain the first result in the stem. However, they were very weak on the $\mathrm{A} = \mathrm{B}$ case.
Explanation for part (i) was poor, and the plus or minus was frequently not properly understood; as a consequence, a specious plus or minus often appeared in part (ii). Arguing necessary and sufficient conditions in (iii) and (iv) was weak. However, a small number of good candidates did complete this question.

Question 7
This was the least popular question in the Pure section of the paper being attempted by less than 30% of the candidates, and whilst there were some very good solutions, the standard of attempts was generally not good, and in fact, only one of the Mechanics questions was less well-answered in the whole paper. In general, the stem was pretty well answered, but even here, having appreciated that each factor on the LHS was a factor of the RHS, frequently there was no consideration given to the, admittedly simple to obtain, scalar factor being one. In spite of the stem, most did not appreciate how to proceed with part (i), and so went little further.

Question 8

Attempted by nearly as many as attempted question 1, it was marginally more successful, and a good number achieved full marks. Generally, the idea of repeatedly applying a function to create a cycle was well-spotted. However, candidates did sometimes fall down trying to find $g(x)$ in (ii) and some substituted the given $g(x)$ rather than finding it. In part (iii), some stopped having made the first substitution and so could not find the solution. Also, some guessed the solution for part (iii) but, of course, this did not do the full job.

Question 9

Although not overly popular, being attempted by less than a fifth of candidates, this question was moderately successful, a little better than question 3. Finding the extensions and tension in the first two parts of the question was completed by most candidates, but having generally written down the equation of motion, very few thought of applying the binomial expansion and so could not proceed to the final result.

Question 10

One of the least popular questions, being attempted by about a seventh of the candidates, it was the least successfully answered with just under quarter marks scored. As ever, there were some very strong solutions. Generally, the first result of the question was done well as they could resolve accurately and identify the condition, > 0 . For the final result, not many identified the condition$T > 0$, and so could not proceed. Generally, energy was conserved well, though some omitted one or other of the kinetic energy terms. As far as circular motion was concerned, some treated the radius as a rather than $\cos \beta$.

Question 11

The most popular of the non-Pure questions, it was attempted by a third of the candidates, but generally, only about a quarter of the marks were scored. A large number attempted to use constant acceleration formulae, or if they realised that calculus was required, failed to appreciate that they needed to use "$a = v\, dv/dx$" . For those that separated variables, the integrations caused few problems. Part (iii) caused difficulties as candidates were not comfortable using the bounds; had they considered $\lambda X_1 - \lambda X_2$ they might have encountered fewer problems.

Question 12

Whilst as popular (or rather unpopular) as question 10, attempts at question 12 were more successful than all but questions 1 and 8 with on average half marks being scored. Part (i) was generally well done using the binomial distribution, and those that spotted they should use the Poisson distribution in part (ii) usually did well too. However, candidates were often sloppy in their explanations of the rearrangements of Chebyshev, and also quite often candidates had a fixation with the Normal distribution which did not help.

Question 13

This was the least popular question being attempted by only half the number attempting question 12, and with slightly less success than for question 11. Most candidates picked up a few marks at the start of the question and then a small number used integration by parts in (i), but others attempted this unsuccessfully trying integration by change of variable. The multiplication of T^4 was surprisingly badly done, and the expectation of a constant being zero was similarly surprisingly common.