STEP III 1996 Comments

Question 1

Yuck! Nothing particularly interesting is going on here, and the difficulty in this question is not mathematical but notational. It didn't require ingenuity, or creativity, just being very careful and meticulous with notation. An important skill, to be sure, but not one that makes an interesting question.

Question 2

A nice question, but a bit too easy for STEP III I think! With the current A Level specifications I don't think most students would have much difficulty here, as long as they are accurate with their algebra while inverting the matrix.

Question 3

I found this difficult to start with, trying a few different substitutions, but once you decide to use the t-formulae the rest of the integration is straightforward. I didn't have any problems with the first definite integral, but it took me a couple of tries to deal with the square root inside the arctan in the second one. I thought it was a bit mean not to give the value of $\tan\frac{3\pi}{8}$ in the question.

Question 4

This is a nice one, and a good example of a well-pitched STEP number theory question. I answered an almost identical question in one of my first year undergraduate example sheets to I had no trouble with it this time!

Question 5

A nice question involving De Moivre's theorem and some roots of polynomials work. If you can spot the link between the first identity and how to write down the polynomials for (i) and (ii), the rest follows.

Question 6

Another groups question that is hard to judge the difficulty of, because it no longer forms part of the STEP specification. It's nice to see some matrix groups where the identity element is not the identity matrix.

Question 7

An algebra-heavy question, although now that roots of polynomials are studied as part of the core pure maths specification, one that is really quite approachable. The bit at the end with the semi-perimeter is a bit random, but nice.

Question 8

A question on Mobius transformations. It seems quite bitty, with each of the individual parts of the question being relatively short.

Question 9

It wasn't immediately obvious to me to compare the gravitational and centripetal acceleration, but once you do that and use conservation of energy you find the point where the particle leaves the sphere. After that, it's just an application of the constant acceleration formulae.

Question 10

A nice statics question. The key is getting a clear and accurate diagram at the start. After that the standard methods of resolving forces and taking moments leads to the desired results.

Question 11

This felt a bit more like a pure question than a mechanics question, with most of the work being geometry and differential equations. I think the final part with the small amplitude oscillations is hard if you haven't seen something like that before (and it could also be done more formally considering limits rather than the small angle approximations).

Question 12

A question about Markov chains – if you've seen them before, this question is easy, but if not making sense of the meaning of the different elements of the matrix is difficult, and realising that in (ii) the vectors are row rather than column is essential.

Question 13

The main inequality in this question is Chebyshev's inequality, an important inequality in probability theory. I liked this question, featuring an interesting bit of maths, with a good hint to help, followed by applying this in a harder context.

Question 14

This question requires confidence dealing with infinitesimals, which isn't a skill usually taught at A Level. The hardest part is getting to the differential equation – the rest is working through the algebra (and using the Taylor series for the exponential).