Responses and comments to the questions

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Balder, Helix, Lisebergbanan, Kanonen

Comments

I. 3 seconds free fall. Quick workout: From 0 to 30 m/s, average velocity 15m/s during 3s

II. Slänggungan: That mass does not influence the angle is a consequence of the Equivalence Principle (intertial mass, in ma, is equal to the gravitational mass, in mg). More discussions and assignments about Chain flyer rides in Physics Education 51 (1) 15014 2016

III. The Kanonen loop has a clothoid shape. The top is a circular arc, matched to Cornu (Euler) spirals at about 70° from the top. Read more about roller coaster loop shapes at Phys. Ed. 51 (3) 013016

IV. The riders, both in front and back of the train move faster over the top than the middlerof the train. The difference is about 0.4g (which you can work out form the angle in the nearly circular arc at the top). During most rides in Kanonen, riders in the middle experience small "negative g's" (around -0.2g) and riders front or back around +0.2g.
The brakes in the launch section are there to stop the train in the case of a "rollback" – if the train doesn't reach the top (read about magnetic brakes)

V. Balder: I counted three beams of parabola, i.e. 7.5m, which takes about 1.2s on the way up and then 1.2s on the way down. More about Balder

VI. The train moves with essentially the same speed all three times. I usually assign this as a task for some of the groups and encourage them to discuss uncertainties in their phone measurements.
It gives an illustration of the energy losses in roller coasters. During about 250m of track, the train has lost potential energy corresponding to 7.5m – an average of 3cm/m, or an effective friction number of 0.03.

VII. The star – but one of the groups claimed it was more like a 7-point star. I will have to go and check again. Interesting task to discuss what is required for a "closed orbit": The alternative in the middle is essentially the orbit for the JukeBox.

VIII. Trampoline jumps – a combination of harmonic oscillator and free fall. For small jumps (where the feet never leaves the mat) the velocity will be a sine function. During high jumps, the time in contact with the mat is a very small part of a full jump cycle. During the time in the air, the velocity falling linearly, with g. In the short contact time, the velocity must increase rapidly. Nice examples for all kinds of modelling exercises. Could have been standard textbook problem, if trampolines had been common, when standard problems were constructed. Read more: http://iopscience.iop.org/0031-9120/50/1/64

Roller coasters.

Balder (from 2003): ... characterised by many occurrences of "air time" with "zero g". Relatively moderate "Positive g's"
Helix (From 2014): Many cases of both negative and large positive g's. Short note: http://tivoli.fysik.org/fileadmin/tivolifysik/Liseberg/helix/first_drop.pdf
Lisebergbanan is from 1987, Classic, but feels quite shakey after going on Helix. Long ride, Noisy data.
Kanonen (2005) Short ride. Characterized by a launch in the beginning.

> A comment about timing in roller coasters. There are basically two timings applying to roller coasters. One is the time from leaving the station until coming back again. The more relevant time for riders is the shorter time between leaving the lift hill chain and entering the final brake. The graphs did not include the final stretch to the station

More articles: http://tivoli.fysik.org/english/articles

Were you different from students? You were clearly more aware of relevant concepts and facts to consider (and had a larger repertoire to choose from). I think that you also had larger expecttaions of being able to answer the questions. Thanks for taking part!

Please contact me if you are interested in including amusement-ride related activities. I would be happy to provide links and materials that might be usfeul. / *Ann-Marie.Pendrill@fysik.lu.se*