

RHETT ALLAIN SCIENCE JUN 3, 2011 7:53 AM

Fair Physics: The Big Slide

The local fair just ended. Of course there is a bunch of physics at these things. Let me share just one for now. More will likely come later. Here is the big potato sack slide. Here is a quick video of some kids sliding at the end level part of the slide. From this motion, [...]

 SAVE Slide 1

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Friction on a fair slide



From this motion, could I get an estimate for the coefficient of kinetic friction? Just as a note, the slide guy would take some pledge and spray it at certain spots on the slide every so often. This sure seemed to make the kids go faster. Faster equals more fun.

Assuming the end of the track is level, then the slider should have the following forces:

 Untitled 1

Technically, both the force from the slide and the frictional force are forces the slide exert on the slider. Typically, the vertical one is called the normal force (and I will label it has F_N). The usual model for kinetic friction says that the magnitude of the frictional force is:

 LaTeX 17

As the slider slides, the acceleration in the vertical direction is zero. This means that the net force in the vertical direction must also be zero. Using mg as the gravitational force (where g is the local gravitational field), I get:

 LaTeX 18

And in the x-direction (horizontal), I just have the frictional force. This should be related to the x-acceleration like this:

 LaTeX 19

Maybe I skipped too many steps there - but you have probably seen something like this before. The point is that if I can get the acceleration of the slider, I can get the coefficient of friction. Notice that the units work (μ has no units) and the acceleration should be independent of mass - which appears to be true.

But how do you get the acceleration? Video analysis with Tracker (free java-based app for Mac OS X, Windows, and Linux). Here is the data from my analysis. Oh - I guessed at the height of the fence that I used to scale the video.

 Data Tool

Notice that I fit a quadratic equation to the data. If something has a constant acceleration, then the following should be true:

 LaTeX 110

Quick note: this assumes that at time $t = 0$, the position is x and the velocity is v . Looking at the fitting function, I have coefficient of 1.47 m/s^2 . If this matches up to the above kinematic equation, then:

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LaTeX 1.11

And with that acceleration, the coefficient of friction (technically kinetic friction since it is sliding) would be:

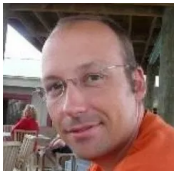
LaTeX 1.12

This seems a little bit higher than what I would expect. Oh well.

Homework questions:

Yes, I am assigning homework.

1. Suppose the slide is 5 meters tall at the top and goes in a straight line (unlike this one). How fast would a rider be going at the bottom if the slide is inclined 25 degrees? (Hint: be careful with the normal force. You have been warned)
2. For the same slide above, how long of a flat level part would you need so that most sliders would stop before falling off the end?
3. What is the smallest angle for the slide that you could expect this coefficient to work? (yes, you have to make an estimate or an assumption)
4. If you charge 75 cents per slide, how much would it take you to pay for the slide? (note: at this fair, you paid for a bracelet that gave you unlimited 'rides')



Rhett Allain is an associate professor of physics at Southeastern Louisiana University. He enjoys teaching and talking about physics. Sometimes he takes things apart and can't put them back together.



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