Dumb Tricks with Metre Sticks

by

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Here are two tricks, sorry, demonstrations that you can store away for when you have a few minutes to kill and all you have available is a metre stick, or when you just feel the need to show off in front of impressionable young students. They both are opportunities to prove that a knowledge of physics is better than being young and co-ordinated.

Trick 1: Challenge a student to balance the metre stick vertically on his/her open flat palm. Even a co-ordinated young athlete will be doing very well to manage 5 seconds or so. In the end, they are dancing back and forth wildly trying to keep the thing from toppling over. Now it's your turn, and being a physicist and understanding the nuances of nature, you will not only beat 5 seconds, but you will do it the hard way. You will do it while at the same time balancing on the end of the stick the massive physics text book that you make your students carry around with them. Of course you have actually given yourself an advantage in disguise.

The period of oscillation of a simple pendulum (whether hanging from a fixed pivot or balanced vertically above a fixed point as in our case) is given by T = 2ð(/g)$^{1/2}$, where g is the acceleration due to gravity and is the radial distance from the pivot to the centre of mass of the pendulum. Really we should be worrying about the moment of inertia of a rigid body here, but this simple analysis will suffice to get the point across. For the unencumbered meter stick, is about half the length of the stick. By putting a very heavy object on the top of the stick, you have effectively doubled the length and increased the period of oscillation. The stick will not only wobble more slowly, but you will have more time to react and keep your hand under the centre of mass of the system. With only a small amount of practice, you can easily beat 5 seconds.

Of course, circus performers and jugglers exploit this principle when they balance plates on the end of a stick. The longer the stick, and the closer to the top of the stick the centre of mass is, the easier the trick is to perform. For more examples of this, think of tight rope walkers and their balance poles and ballet dancers who invariably do their hardest *en-point* manoeuvres with their arms above their heads.

Trick 2: Begin by placing your metre stick horizontally on your two outstretched index fingers, one at each end. You should wonder out loud how hard it would be to slide your fingers toward each other and keep the stick in balance at all times, finally ending up with your fingers touching each other at the centre of the stick (and then you could remove one finger and end up balancing the stick on the other). But wait, this is too easy. Confidently, you ask a student to place their "door stop of a physics text book" anywhere upon the length of the stick. You begin sliding your fingers toward each other, and you will find automatically that first one finger will slide, then the other, and so, until your fingers are touching one another and the book has remained in balance at all times.

The catch is that the force of friction opposing the motion of each finger is proportional to the normal force acting on the finger. The one closer to the book will not slide initially because of the larger normal force and, hence, larger friction force. The other finger will slide until the dynamic force of friction opposing its motion becomes greater than the static friction opposing the other. When this happens, the other finger (now farther from the book) will begin sliding and the finger that was originally sliding will cease to slide. Only one finger will slide at a time. It will appear that you are concentrating very hard on which finger to slide and on how far to slide it when, in fact, the laws of physics are taking care of all of this for you.

It is possible, in this way, to devise a simple experiment to measure the ratio of the static and dynamic coefficients of friction between wood and flesh. Or, if you outfit each student with a metre stick and two pencils (to replace your fingers), it makes a very inexpensive experiment to study frictional forces.

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