COMPILATION: Unit 7 - Two Spring Energy Lab Practicums

Date: Tue, 08 Feb 2000
From: John Barrere
Subject: energy lab practicum

Given spring characteristics (pre-load and K) and a specified target velocity, calculate a combination of system mass and stretch of the spring to give the target velocity. Pasco cart w/picket fence attached and photogate to measure velocity at the point where spring has fully recovered. Gives computational practice as well as assessing measurement skills. Grade based on % error. I got excellent results, I'll see how the kiddos do!!

Date: Tue, 08 Feb 2000
From: Joseph Vanderway <jvanderway@CSUN.EDU>
Subject: Re: energy lab practicum

I just tried the following with my AP students:

Given a spring, and knowing the height of a tissue paper "drum", the students must position the spring at the correct height from the lab table top such that when a felt-tip pen is attached to a hooked mass (dimensions and mass given), and released from the spring's un-stretched position, the pen drops down and marks, but does not penetrate the tissue paper.

Students were given free run of the lab, and they had to find the k and pre-load of the spring on their own. Most students didn't do well on their first try - they made errors in solving the problem, not in measurement! - but on the second try I had some success. They seemed to like it.

Date: Thu, 10 Feb 2000
From: Patty Blanton <blantonp@APPSTATE.EDU>
I've done the same thing with an egg as the target. The idea is not to crack the egg.

Date: Thu, 10 Feb 2000
From: John Barrere <forcejb@YAHOO.COM>
Subject: spring energy lab problems

Help!! We (and I) got some results I'm not sure I understand. A lab investigating maximum velocity as a function of mass (at constant elastic energy) gave slopes of the v^2 vs. 1/m graph that were 1.65 - 1.80 times the system energy instead of the theoretical 2.0 times energy. So this would seem to be an error of 10-20%. Using the IDENTICAL setup, I assigned groups different target velocities; their practicum assignment was to compute a combination of mass and stretch (energy) to produce that velocity. Most results were accurate within 3-6%. Why the apparent large difference in accuracy for what is basically the same experiment?

The only thing I can think of is that the lab accuracy was based on the slope of data that had been transformed by squaring the velocity. If I square the 3% and 6% values (from the practicum), that roughly corresponds with the error range observed in the lab. Should the error on the lab be computed differently?

The results of velocity vs. stretch (i.e., energy) at constant mass gave much better percentage agreement with theory (twice the inverse mass). I'm probably exposing my lack of knowledge of statistics here.

Date: Sat, 12 Feb 2000
From: John Barrere <forcejb@YAHOO.COM>

I've had some local feedback and actually an original idea on the subject of relatively poor agreement of the slope of the v^2 vs 1/mass "horizontal car launch" lab (Friday's posting). Slope should be 2E and we all get (mostly) 1.5E - 1.7E. One suggestion is that since the slope is supposed to be 2E, any error in the measurement of E will be doubled with poor accuracy as a result. Another possibility: the physical variable measured that determines E is the spring stretch (measured with a meter stick) and since E, which is being held constant, is partially dependent on the SQUARE of stretch, any inaccuracies will therefore be magnified. This in turn suggests that the best spring for this kind of lab would be high pre-load with low spring constant, if there is such a beast. Of course, NEITHER of these explanations addresses why the error is consistently on the low side.

As for the v^2 vs. E investigation at constant mass, no repetitive measurements of mass are necessary, so there is basically no chance for error and the slopes DO come out much closer to 2(1/mass), but the errors once again are consistently on the low side so we're still looking at a predominantly systematic rather than random error.

One other thing I realized about our lab setup that increases "losses": the unstretched end of the springs were not rigidly fixed to anything. With one type, a C clamp screw passed through the large loop at the end; the other with a smaller ID loop was tied to the clamp with a short length of string. So, when the car is released, some of the energy accelerates the spring and makes it translate (slide). I should probably work out a way to really FIX the fixed end, but my clamping options are pretty limited. Of course, most of the students nonetheless got very good results on the "target velocity practicum" we did. So the string(s) in the system is(are) not the main issue.

Date: Sun, 13 Feb 2000
From: greg groeschl <gresh@IDCNET.COM>

With regards to the energy lab -

Don't wheels roll? Don't rolling objects have rotational kinetic energy? Isn't this analogous to the ball down a ramp? The GPE and KE cannot alone account for the speed at the bottom of the ramp. You will always come up short. Doesn't PASCO send wheel info in the cart documentation so you do not have to tear one apart?

Next year, try dry ice. It rarely rolls.

RESPONSES TO THE ABOVE POSTS, IN LATER YEARS:

Date: Fri, 10 Jan 2003
From: Vonnie Hicks <VMHicks@AOL.COM>
Subject: spring frustration

Concerning John's frustration with energy labs with springs: I have gotten a lot of mileage out of springs wound from 12 ga wire used for hanging suspended ceilings. Broomstick works, but a large dowel in a scrap-wood jig handles the wire with less risk to eyes. The wire comes in rolls, but is cheapest in 12-foot lengths which sell for about 20 cents at Home Depot. These can be hung in series or parallel to investigate the effect on k-values, and make nice oscillators when hung from above supporting up to 2.5 kg of mass. I even use them for human-scale spring scales, and it is no
tragedy to exceed the elastic limit.

What has become extremely clear from working with these springs is that the mass and motion of the spring itself consumes a great deal of the elastic energy released when the spring expands or contracts, as can be witnessed by natural oscillations occurring from suspended spring arrays. The
conservation laws assume that the springs are massless, and mine clearly are not. It can be especially challenging to deal with because the mass is distributed along the length of the spring rather than concentrated at the end, so k-value and supported mass vary inversely along the length of the spring. I would suggest that kinetic energy of the spring itself - even a 'good' one - might account for the 'missing' energy.

Date: Sun, 12 Jan 2003 07:54:00 -0700
From: Larry Dukerich <dukerich@asu.edu>

Vonnie Hicks wrote:
> ... I would suggest that kinetic energy of the spring itself-even a
> 'good' one-might account for the 'missing' energy.

Ordinarily, we try to find labs that yield straightforward results so that students grasp the concepts the lab is supposed to help them see. However, by this time of the year, it doesn't bother me too much for students to recognize that the real world is often pretty messy and that simple models - "all the elastic energy is transferred into kinetic energy" - don't always apply to the situations at hand. I would prefer that the slope of E vs v^2 were 1/2 m, but when it's not, I expect my students to try to account for why not.