COMPILATION: Unit 7 - Gravitational Potential & Energy

Date: Sat, 29 Jan 2000
From: John Barrere <forcejb@YAHOO.COM>

I'm trying to come up with a gravitational potential (gh) vs velocity exercise. We talked a lot last summer about the advantage of introducing field potential with gravity as a later bridge to this subject in electric fields. Plotting v vs. h (for a vertical or ramp "drop") and then linearizing by squaring v would yield a slope of 2g. But I can't see a way to conjure up a reason to combine g and h into "potential". Any thoughts? Has this already been worked up and I'm just spacing it??

Date: Sat, 29 Jan 2000
From: Jean Oostens <joostens@campbellsville.edu >

Here is an old exercise I did in the days of air tracks: I had to assemble air tracks out of their boxes, and make sure they were straight.

I mounted a photogate at the low end of the track, and launched the cart from various positions (x) upstream. If the track had been straight, the plot of v^2 versus x would have been a straight line. Surely enough, it never was the first time around, and the plot reflected the various bends and kinks of the track. All I had to do then was to "level the mountains and fill the valleys" by adjusting the pillars. Up to 3 iterations were necessary to pass my own high standards.

For this to work well, one needs a very small slope, and little friction. To adapt this to dynamic carts, the track should be deliberately deformed (but not permanently). Friction can be taken care of by an appropriately chosen overall slope.

On the other hand, I have recently worked (in my basement) on a magnetic Atwood machine: One of the masses is a magnet, and it passes through a flat horizontal coil of diameter 2R and N turns, i.e. is subject to a calculable magnetic field

B = MuZero I N R / (z^2 + R^2)^1.5

where I is the current.

As the force on a dipole is proportional to the gradient of the field, B is proportional to the potential generating the additional force on the falling (or rising) magnet. If the two masses are unequal, the total potential has a linear component V = deltaM g z

One can compare the v^2 versus z plot with I = 0 and the field on, and isolate the magnetic part. I obtain a good fit using the measured value of R and an overall scaling parameter including the magnetic moment of the magnet.

The other mass is monitored with a CBR ranger and a TI83. The analysis is done using Vernier's "GRAPHICAL ANALYSIS", introducing additional columns to calculate v^2 and the formula for the potential.

Of course, reversing the polarity and the direction of motion gives 5 different graphs to compare, and each of the ones with the current ON should accept the same value of the overall coefficient.

Date: Mon, 31 Jan 2000
From: Gregg Swackhamer <pswackhamer@GLENBROOK.K12.IL.US>

John Barrere asked about gravitational potential.... From the student point of view, Who needs it? Really, there is not a lot of use that I have for it with respect to mechanics. One COULD make use of it, but I have not. About the only things I do with it are:

Introduce Vgrav as the "energy load factor" associated with particular positions that some object could have. (Joules of Egrav/kg) It is not introduced through some empirical necessity.

Make a graph of Vgrav vs vertical position for our classroom. The slope is recognized as -g.

A plot of Egrav vs x along a path from a hypothetical planet to a hypothetical moon permits questions about the value of the field along the way and the amount of energy that needs to be given rocket payloads of various mass for trips from planet to moon and the reverse.

We go from there directly to the analogous Velec in J/C (what voltmeters measure) and from there to uniform electric fields created by parallel copper plates in a dish of water.

So far I'm pleased with the improvement in the ability of students to deal with energy flow in circuits because of this kind of development of potential. IV is now just found for a one point at a time in a circuit (rather than using IV where V is the difference in potential between two points), because it now is seen to be the rate of energy flowing past that point. At another point downstream IV may be less, so the question then is, What happened to the energy?

Also, I like students to consider the strength of the electric field in circuits (it along with resistance accounts for the size of the current), and this opens the door for that, too.

COMMENT on Gregg's post, A YEAR LATER:

Date: Thu, 7 Dec 2000
From: "Daniel L. MacIsaac"

Gregg Swackhamer wrote:
> Introduce Vgrav as the "energy load factor" associated with particular
> positions that some object could have. (Joules of Egrav/kg) It is not
> introduced through some empirical necessity.

We actually call this 'Liftage' and relate it to plumbing 'head'. Obviously we're trying for the comparison, gravitational liftage is like electric voltage.

David Cole defines mass as inertial charge as well :^)