COMPILATION: energy before force!

Date: Mon, 17 Feb 2003
From: Don Yost <DoYost@AOL.COM>

Physics first seems to be gaining some ground. I would argue strongly against it if the courses remain as they are and the order simply reversed. If the courses were redesigned, however, physics, chemistry, and biology, (then some more physics) seems pedagogically sound.

In designing new courses, there seems to be some common threads weaving though all the sciences: energy, particles, and light. While chemistry and biology can be presented using these models now, physics traditionally begins with force: a rather limited concept for chemistry and biology.

The challenge, then, seems to be: how do you structure physics so that the main theme involves particles, energy, and light, and from these develop force, rather than the other way around? In this way*, all three subjects would start with the particle nature of matter, energy, and then consider light.*

If we start with energy, then the problem becomes: how do we get to force? Do we develop force as a component of energy transfer (through work), or do we consider force to be the gradient of a potential field (much like considering contour lines on a mountain: where the contour lines are close together, the force is large, and where the contour lines are far apart, there is little force).

U.C. Davis has developed a pre-med physics program which teaches energy before force, and it does seem to have a logical flow. Has anyone out there considered this approach? (Yea, I know; after 11 years of modeling, who wants to start over?) Still, I see this as the next possible step in the evolution of physics instruction.

Date: Tue, 18 Feb 2003
From: Kent Ellis <kemarble@HOTMAIL.COM>
Don Yost,

You caught my interest in your latest inquiry about teaching energy before force. In my short career - one year of algebra and four years teaching HS physics - I have attempted teaching the Modeling energy unit prior to kinetics and dynamics in about half my classes. I've had some successes. I'm somewhat familiar with the UC Davis curriculum. Three years ago I downloaded what I could of the course and tried to adapt it to my physics classes. We started with the qualitative worksheets from the Modeling curriculum, modeling energy by means of transfer and storage mechanisms, then began to quantify the transfer by means of the UCD particle model. We heated a piece of iron, dropped it into water and determined the energy transfer from the change in temperature to equilibrium. Whiteboard drawings of packets of energy moving across the boundaries of the system helped students to articulate the mechanism. I believe the students achieved a fairly good level of understanding, but alas, we could not really verify our experiment because we lacked the equipment to compare the temperature of the hot iron to our predicted results.

This term (we're on a block schedule) I'm attempting to quickly investigate Newtonian mechanics - within the first five weeks - then fill the balance of the term with energy dynamics. The bungee-drop, formerly an event at the Science Olympiad, is an outstanding lab using the concepts of.energy transfer - much easier to solve the challenge with energy transfers than with force analysis. This event requires that an elastic rope, no shorter than one meter, be attached to a non-elastic rope. There are minimum and maximum values for the spring constant of the elastic component. Given a mass and a height from which to drop it, the students must figure out how much of the non-elastic rope should be let out so that the mass comes closest to the ground without touching it when it is dropped.

The *Minds on Physics* text-workbook illustrates a force problem with two magnets attached to the ends of springs. I've not yet developed the lab, but I have in mind the process of modeling the inverse square law as well as Thermodynamics Law 1 with such a contraption, maybe attached to carts on an air-track.

I'm also developing a model of ubiquitous friction as a means of understanding Thermodynamics Law 2, and Newton's third law, simultaneously. The TDLs are amongst the only physical science standards listed for AZ schools; Newton's laws are not named explicitly in the state standards.

Please understand, these variations on the Modeling curriculum are under construction. I'd be very appreciative of following this thread on this listserve. I've found that the *students seem to respond better to the concepts of energy transfer and storage than they do to force dynamics.* I have the FCI comparisons to help monitor my success rate, but I must also bear in mind that my few years in this profession probably contribute more to their scores than the material we model.

I regret that I've not been able to attend any further Modeling Workshops during the summer sessions. I must use the summer break to produce the income my family requires so that I can continue to teach. Perhaps an online workshop to develop the resources would be in order.