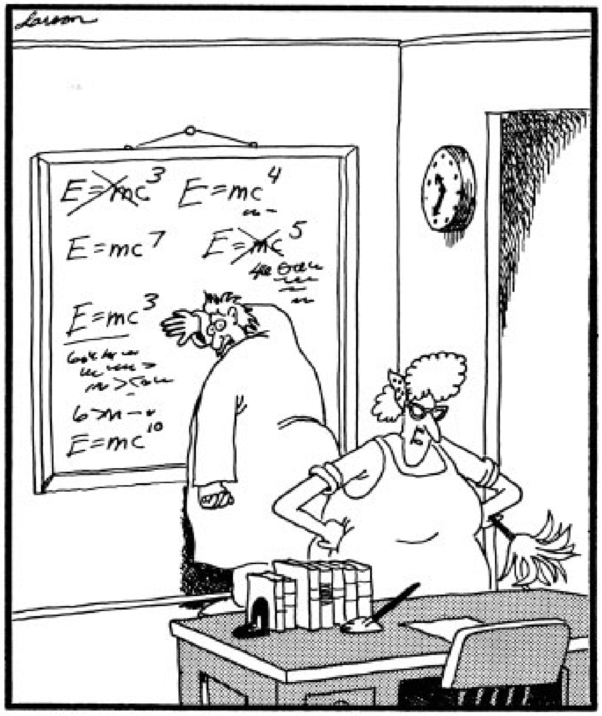
Physics 8D lab activities

Special Relativity 1.0



"*Now* that desk looks better. Everything's squared away, yessir, squaaaaaared away."

From 'Valley of the Far Side' by Gary Larson
(Andrews and McMeel, Kansas City and New York)
ISBN 0-8362-2067-6

The light clock

1. go to the light clock website
   http://galileoandeinstein.physics.virginia.edu/more_stuff/flashlets/lightclock.swf
2. Set the speed of moving mirror to .6c. Run the applet until the light has made a full "round trip" , about 10 seconds for Jill. Record both Jack and Jill's clock reading.
3. use the relationship: $\Delta t = \gamma\tau$ to determine γ using both times.
4. determine β from the relationship: $\gamma = \dfrac{1}{\sqrt{1-\beta^2}}$
5. does your result from 4 confirm that v = .6c?
6. Now working backwards, let $\gamma = 2$ and solve for β and v
7. Set the speed to equal the value of v you found in step 6 above.
8. Run the simulation and use the values of the two clocks to confirm that $\gamma = 2$.
9. Repeat 2 – 5 for the highest speed possible in the simulation.

Length contraction and time dilation

1. Go to the website: space and time in special relativity

You will see two frames of reference…the upper frame represents a space ship moving at speed v past the lower "lab frame". Note that by clicking in the upper frame, you shift your point of view to that frame. The bouncing dots are photons bouncing off mirrors on the top and bottom of each frame, synchronized when the two frames are at rest.

1. Set *beta* to a value of 0.6

2. Run the simulation and then pause it when the upper frame is above the lower frame. Note that the grid marks are more closely spaced in the upper frame than the lower frame. Why is this (you don't have to write down the answer but you will need to know!)? Once you know the answer, use a distance measurement to determine γ, and then solve for *beta* as before. In this case, you will use the length contraction relationship:

$$L = \frac{L_o}{\gamma} \qquad \textbf{Eq. 1}$$

Where L_0 is the length of the "spaceship" or grid patter in the lower frame and L is the length in the upper frame.

3. Note that by clicking in the upper frame, you can see the elapsed time in that frame. Calculate gamma and beta from the time measurement. Does it agree with your value from step 2?

3. Repeat Step 2 for a second value of $\beta = 0.8$.

4. Note that as the upper frame moves to the right, two yellow flashes go off simultaneously in the lower frame. Would they be recorded as simultaneous by any observer in the upper frame? For a velocity of v = .8c, how far apart ***in time*** would an observer **in the center of the space ship** measure the two pulses to be?

5. Now, notice that the dots moving up and down represent photons of light bouncing off mirrors. Why don't the photons in the upper frame line up with each other? How does this relate to the principle from #4?

6. Note that the photons in the upper frame are moving more slowly upwards than the photons in the lower frame. Change the speed and observe what happens. Does this violate Einstein's first postulate, or is it required by the first postulate. Explain. Is this consistent with the condition for transverse relativistic velocity: $u_y' = \frac{u_y}{\gamma}$?

7. Think of one other experiment or observation you can make using this simulation and do it! .