

## PHYSICS 5I

### Homework 2

Due in class, Wednesday October 21

1. An observer on Earth sees an alien vessel approaching at a speed  $0.6c$ . The star ship enterprise comes to the rescue moving at speed  $0.9c$  towards the alien vessel and the earth. What is the speed of the Enterprise as seen by the alien vessel?
2. In the Wild West, a marshall traveling in a train moving at speed  $v = 35$  m/s sees a duel between two cowboys on earth 55 m apart parallel to the train. The marshall observes that, in his frame, the two guns went off at the same time.
  - (a) Which cowboy fired first; the one the train passed first (A) or the second one (B)?
  - (b) How much earlier did he fire.
3. A physics student thinks that he can fit a 12-m long pole into a 10-m long barn, if he runs fast enough carrying the pole. Is this possible from the point of view of (a) an observer on the ground, (b) the running student? Explain the apparent contradiction.  
*Note* that for the running student it is the barn which appears to be Lorentz contracted.
4. (a) What is the speed  $v$  of an electron whose kinetic energy is 14,000 times its rest energy?  
Give your answer as a value for  $1 - v/c$ .
  - (b) Such energies are reached at the Stanford Linear Accelerator Center (SLAC). At SLAC the electrons travel in a tube (which you cross on Interstate 280) that is 3.0 km long. How long is this tube in the electrons' frame.
5. How many grams of matter would have to be totally converted into energy to run a 100-W lightbulb for 1 year?