Physics 139
Spring 2014
Homework 2
Due Friday, February 7, 2010

Reading Assignment: Hartle, pp. 42–45, 47–70. In lecture I went into more detail than Hartle does on variational principles of mechanics, because this subject is explained badly in most books. You may wish to also look at Secs. 4–7 of the Supplemental Notes on classical mechanics that I posted (see the web site for the link). Also, my derivation of the Lorentz transformation was different from that in the book; see my lecture notes for January 30 for that.

1. Problem 3.5, p. 46.

2. Problem 4.2, p. 73.

3. Problem 4.5, p. 74. This problem just involves plugging in numbers, but make sure you understand the apparent "superluminal" motion.

4. This is basically problem 4.6, but do it this way.

(a) The primed frame is moving with velocity v down the x-axis of the unprimed frame. A clock is constructed in the primed frame by having a light pulse bounce back and forth between two stationary (in the primed frame) mirrors placed at positions $x' = 0$ and $x' = L_0$, that is, at a distance L_0 apart as seen in the primed frame. The tick of the clock is each time the light pulse bounces off the left mirror (at $x' = 0$). Thus, as seen in the primed frame, the time between ticks is $2L_0/c$. The origins of the two frames coincide when $t = t' = 0$.

Let event A be the bouncing of the light off the left mirror, event B be the bouncing off the right mirror, and event C the bouncing off the left mirror again. Let event A occur when the origins of the two coordinate systems coincide. Draw a space-time diagram $(1 + 1$ dimensions) in which the x- and ct-axes are orthogonal on the paper. Draw the x'- and ct'-axes; the world lines of the two mirrors; and the world lines of the light pulses between bounces.

Compute the times t_B and t_C ($t_A = 0$ by the way we set the problem up), and show that the time dilation emerges as expected.

(b) Do this problem again, except the light bounces between two mirrors at positions $y' = 0$ and $y' = L_0$, as seen in the primed frame. The motion is still in the x-direction. Don't try to make a space-time diagram, since it would have to be done in $2 + 1$ dimensions, but do calculate t_B and t_C as before and show that the time dilation emerges as before.

5. Problem 4.14, p. 75. This will involve a lot of algebra unless you organize the calculation carefully.