Solutions to these problems are due at the start of lecture on June 4.

1. Page 884, Question 3. Add: By how many seconds per day will the two clocks differ?


4. Page 885, Problem 7. (This problem is called a two-star problem, but it is not actually that hard.)


6. (muon decay) (a) Make a spacetime diagram (a graph of $t$ vs $x/c$) illustrating the muon decay process, in which the muon is born (created) at $(0, 0)$ and dies (decays) at $(0, t)$, where $t = \tau = 2.2 \times 10^{-6}$ seconds. (The muon is at rest in this frame.)
   (b) Now make a spacetime diagram illustrating the muon decay process, but this time with the muon traveling at a speed $v = 0.8c$. Thus take the muon to be born at $(0, 0)$, and to die at $(x/c, t)$, where $x = vt$. Make the scales of the $t$ and $x/c$ axes the same as in part (a)—maybe 0.2 or 0.5 of a microsecond per centimeter along each axis. At what value of $t$ will the muon die? How far will the muon have traveled between birth and death, i.e., what is the value of $x/c$ when the muon dies? Be sure to indicate where the value of $\tau = 2.2 \times 10^{-6}$ seconds exists on your spacetime diagram, i.e., what line on your diagram has a length equal to $\tau$? (This will illustrate the non-Euclidean nature of spacetime—it is not the geometry of ordinary space, not the (Euclidean) space of the paper surface on which you represent your diagram.)

7. (Clock “paradox”) Suppose we have two muons (A and B), both of which are born at $(0, 0)$. Muon A remains at the origin. Muon B moves at $v = 0.8c$ to the right from the origin. Then at time $\tau/2$ (as measured by a clock in the B reference frame) it reverses its direction (so that $v$ is now $-0.8c$) and so returns to the origin $(x/c = 0)$ just as it dies $\tau$ seconds later (as measured by the B clock).
   (a) Make a spacetime diagram showing the paths of the two muons.
   (b) What is the time, as measured by a stationary clock kept at $x/c = 0$, at the moment when the B muon returns to $x/c = 0$?
   (c) Will muon A have died by this time, or will it still be living, and what will be the difference in the clock A and clock B readings?

8. Page 886, Problem 16. (Hint: Show the world lines of both twins on a spacetime diagram.)


10. Page 887, Problem 34.