[1] Consider a proton accelerated to 1000 MeV. Find the relativistic mass of the proton, its momentum (both in MeV/c and in kg m/s), and its velocity as a fraction of c.

[2] (a) For constant-force motion in special relativity, your text has the result (12.62) for the hyperbolic motion of a particle. Show that this relationship can be placed in standard form for a hyperbola. (This would be something like $(x-x_0)^2 - (ct - ct_0)^2 = \alpha^2$.) Also determine the equation of the straight line that is the asymptote as $t \to \infty$.

(b) Show that it is possible to outrun a light ray, by starting from rest and running with constant force, if you have a sufficient head start. Determine the amount of head start time needed in terms of $F$ and $m$.


[4] An infinite charged wire carries positive charge density $\lambda$ in its rest frame.

(a) With the wire aligned along the $x$ axis, and moving with velocity $v$ in the positive $x$ direction, find the electric and magnetic fields at a point $+d$ on the $z$ axis. (Notice that the Lorentz contraction must be included to obtain the correct values.)

(b) From your fields in part (a) construct the field tensor, $\tilde{F}$.

(c) In a frame boosted by velocity $v$ along the $x$ direction, the wire will appear to be stationary. Construct the Lorentz transformation matrix for such a boost, and carry out the tensor transformation of the field tensor due to such a boost. The tensor transformation is given by equation 12.114, or may also be written as, $\tilde{\Lambda} \cdot \tilde{F} \cdot \tilde{\Lambda}$. [The latter shorthand form assumes that the tensor $F$ has double-contravariant form (two raised indices) as in (12.118) of the text. In this case the transformation requires two matrices $\tilde{\Lambda}$, rather than sandwiching with $\tilde{\Lambda}^{-1}$ and $\tilde{\Lambda}$ as you might guess by analogy with standard rotation matrices.] Show that the resulting field tensor has the expected form for the electric field of such a charged stationary wire.