PHYS420 (Spring 2002)
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Homework # 4
(due Monday, February 25th, 2002)

Problems

1. **SMM, Chapter 1, Problem 26.**

2. **SMM, Chapter 1, Problem 27.**

3. **SMM, Chapter 1, Problem 33.**

4. **SMM, Chapter 1, Problem 36.**

5. *Follow up to Homework 2, problem 7.* If we solve the scalar relativistic Newton's equation, $F = \frac{\partial p}{\partial t} = \frac{\partial}{\partial t}(\gamma mv)$, where $\gamma \equiv \left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}}$, for the velocity *v(t)*, subject to the conditions of a constant force F_0 and initial velocity v_0, we get:

$$v(t) = \left(\frac{F_0}{m}t + \frac{v_0}{\sqrt{1-\frac{v_0^2}{c^2}}}\right)\left(1 + \frac{1}{c^2}\left(\frac{F_0}{m}t + \frac{v_0}{\sqrt{1-\frac{v_0^2}{c^2}}}\right)^2\right)^{-\frac{1}{2}}$$

Consider a small 1 kg object starting from rest, subject to a force F_0 of 100 N.
(a) Using the *non-relativistic* speed equation (i.e. $v(t) = \frac{F_0}{m}t + v_0$), how long would it take for the object to reach the speed of light? Give your answer in days.
(b) Using the *relativistic* speed equation, what's the speed after the same period of time?
(c) Plot both equations as a function of time from 0 to the time computed in (a)?

6. *Extra Credit Problem 1.* Derive the relativistic speed equation from problem 5. *This looks a lot harder that it is. Give it a try.*

7. *Extra Credit Problem 2*. Show that the relativistic speed equation reduces to the non-relativistic speed equation when *v(t) « c*. *Hint: To do this, we must assume that v0 « c and that t is very small. Mathematically speaking, this is the equivalent of throwing out terms that have v_0^2/c^2 and t^2 in them.*