General Physics II: Tutorial Material 2

1) Your spaceship travelling at $0.90c$, needs to launch a probe out the forward hatch so that its speed relative to the planet that you are approaching is $0.95c$. With what speed must it leave your ship?

2) If you were travelling away from Earth at speed $0.5c$, would you notice a change in your heart beat? Would your height or waistline change? What would observers on Earth using telescopes say about you?

3) When it is at rest, a box has the form of a cube 2.0 m on a side. This box is loaded onto the flat floor of a spaceship, which then flies and passes us with a horizontal speed of 0.80c. What is the volume of the box as we observe it?

4) Let us define two event seen in S frame to be $E_1(t_1, x, 0, 0)$ and $E_2(t_2, x, 0, 0)$, i.e. the two events happened at the same space coordinate. S' frame is moving with a constant velocity, v, in the positive x direction and the same events seen in S' frame can be denoted as $E_1'(t_1', x_1', 0, 0)$ and $E_2'(t_2', x_2', 0, 0)$. Using the Lorentz transformation, show that $\Delta t' = \gamma \Delta t_0$ where $\Delta t_0 = t_2 - t_1$ and $\Delta t = t_2' - t_1'$.

5) If a particle moves in the x-y plane of system S with a velocity u in a direction that makes an angle θ with respect to the x axis, show that it makes an angle θ' in S' given by $\tan\theta' = \sin\theta\sqrt{1-(v/c)^2}\big/(\cos\theta - v/u)$, where $v < u$, and S and S' are equal to what defined during the lecture.

6) Can a particle with non-zero rest mass attain the speed of light?

7) An electron is limited to travel at a speed less than c. Does this put an upper limit of the momentum of an electron?

8) A particle travels at $u = 0.10c$. By what percentage will a calculation of momentum be wrong if you use the Newtonian formula. Repeat this for $u = 0.60c$.