

Special Relativity Exercises 1:

LENGTH CONTRACTION & TIME DILATION

In this exercise you will solve some basic problems illustrating length contraction and time dilation. Keep in mind that the limitations of the rounding errors on a calculator may prevent a solution. You may need to use the binomial expansion.

- [easy] 1. The front of a building facing a street is half as high as it is wide. A high-speed spacecraft is traveling parallel to the building at $0.87c$. What does the building look like to the passengers on the spacecraft?
- [medium] 2. The Milky Way galaxy is approximately 10^5 light years in diameter. A proton is traveling at $0.99999c$ relative to the rest frame of the galaxy. How long will it take the proton to traverse the galaxy as measured in
- a. the rest frame of the galaxy?
 - b. the rest frame of the proton?
- [medium] 3. A box at rest in the laboratory has dimensions given by $L_o \times W_o \times H_o$. The box is completely filled with a fluid of density $\rho_o = 1.5 \times 10^3 \text{ kg/m}^3$. If the box is given a velocity of $0.6c$ along its L_o dimension, what will be the measured value of ρ in the laboratory frame?
- [hard] 4. In the rest frame of the Earth the distance between Edmonton and Montreal is about 4000 km. By how much is the distance shortened when observed by a jet, the space shuttle and a cosmic ray. (Hint: You will need to make estimations).