# PHY151H1F – Relativity Module: Instructor Guide

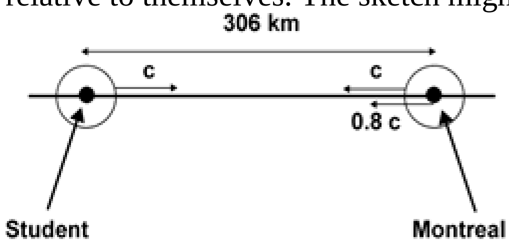
## Special Relativity Module, Activity 15 (15 minutes)

A. When you type 1, gamma = 1.01, $v = 0.4\times10^8$ m/s, ~1.5 seconds
B. When you type 5, gamma = 1.28, $v = 1.9\times10^8$ m/s, ~2.0 seconds
C. The horizontal mirror must be closer so that a reflecting light pulse takes the same travel time going on the vertical route and horizontal route in the clock reference frame.

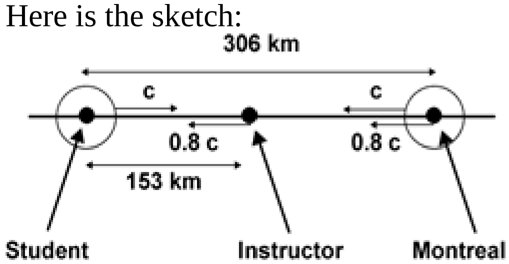
## Special Relativity Module, Activity 6 Activity 3 *(60 minutes)*

**Note:** if you haven't thought about Relativity for a while you may find some parts of this Activity are challenging for you. Please be sure you understand before trying to discuss with your students.

A. Montreal: $\sqrt{1-.8^2}\,510 = 306\,km$ . Kingston: *153* km.
B. Students may be tempted to think of themselves moving towards Montreal at 0.8 c while the light from Montreal is approaching them at c. This is wrong! The students are always stationary relative to themselves. The sketch might look like this:




So the answer is the time it takes for light traveling at c to travel 306 km, the answer from Part A. 1.02 ms.
C. The Teammate's speed is zero relative to the student. The two flashes are emitted simultaneously, both a distance of 153 km away. Thus, the Teammate will see the flashes simultaneously 0.51 ms after they were emitted.
D. Here is the sketch:




Thus we can see immediately that the light from Toronto will reach you (the Instructor) before the light from Montreal catches up with you. Numerically:

$$ct_{Toronto} + 0.8c\,t_{Toronto} = 153\,km$$
$$t_{Toronto} = 0.32\,ms$$
$$153\,km + 0.8ct_{Montreal} = ct_{Montreal}$$
$$t_{Montreal} = 2.55\,ms$$
$$\Delta t = 2.23\,ms$$

E. Students will sometimes get into such a state of cognitive dissonance that they end up claiming that the music played for them but not for the professor! To get an idea of the sorts of things that can happen, here is a link to the article on which this Activity is based: http://scitation.aip.org/dbt/dbt.jsp?KEY=AJPIAS&Volume=70. The article is on page 1238 of the December issue.

**Further Discussion.** After your students have gotten this reasonably sorted out, you might wish to have them figure out the time between the two flashes of light as measured by you, the Instructor. The key is that for you the two events occur at the same place, so the time interval is the *proper* time. Thus:

$$\Delta\tau = \sqrt{1 - v^2/c^2}\,\Delta t = \sqrt{1 - .8^2}\,2.23 = 1.34\,ms$$