**Lab R2: Time Dilation and Length Contraction**

You will use the Train “Paradox” simulation again, this time studying the time intervals between events that occur and the distances between endpoints of objects that move on the screen. Run

the SPACETIME Java Applet, then open the Train\_Ground.sce scenario that you used in Lab R1.

**Collecting Data:**

Use the clocks and distance scale for the ground observer’s reference frame to determine the four quantities in the table below, as measured by the ground observer. Then use the clocks and distance scale for the train’s reference frame to determine the four quantities in the table below,

as measured by the train passenger. Pay attention to units of all numbers ! Finally, decide which reference frame measures the rest time, or rest length, for each measurement.

|  |  |  |  |
| --- | --- | --- | --- |
| **Measurement** | **According to**  **Ground Observer** | **According to Train Passenger** | **Which RF’s (G’s or T’s) measurement is rest (and how do you know) ?** |
| L = Length of train |  |  |  |
| D = Distance between ground  observer’s left and right clocks |  |  |  |
| ∆t = Time interval between (front of train and ground observer’s right clock being side-by-side) and (rear of train and ground observer’s right clock being side-by-side) |  |  |  |
| ∆T = Time interval between front flash reaching train passenger and rear flash reaching train passenger |  |  |  |

**Analysis:**

Whenever you write equations below, use the variables defined in the table above, but add appropriate subscripts (G or T) to indicate the reference frame to which your variables apply.

1. Use the data you collected to determine the speed of the train (in units of c) as measured by the ground observer. Is your answer consistent with the lane in which the train moves, according to the ground observer ?

2. Use the data you collected to determine the speed of the ground (in units of c) as measured by the train passenger. Is your answer consistent with the lane in which the ground moves, according to the train passenger ? How should your answers to this question and question #1 compare to each other ?

3. Calculate γ for this situation.

4. For each row in your data table, write the appropriate time dilation or length contraction equation that relates the measurements made by the ground and train reference frames. Then use your actual measurements and value of γ to verify explicitly that the equation is true.