Name:____

$$v = \frac{\Delta x}{\Delta t} \qquad \frac{\text{speed 1} \pm \text{speed 2}}{1 \pm \dfrac{(\text{speed 1})(\text{speed 2})}{c^2}} \qquad \Delta t_{proper} = \Delta t_{2-clock}\sqrt{1-\left(\frac{v}{c}\right)^2} \qquad L_{other} = L_{rest}\sqrt{1-\left(\frac{v}{c}\right)^2}$$

$$c = 3.0 \times 10^8 \text{ m/s} = 1 \text{ lt}\cdot\text{s/s} = 1 \text{ lt}\cdot\text{min/min} = 1 \text{ lt}\cdot\text{y}r\text{/yr, etc.}$$

1) You are standing on a train moving at constant velocity of 0.5*c* to the right with respect to the ground. You shine a pulse of light to the left. The speed of light is 1.0*c* in your reference frame. What does a ground-based observer measure for the speed and direction of the light pulse?

0.5*c* (to the left)	**1.0*c*** (to the left)	**1.5*c*** (to the left)	**0.5*c*** (to the right)	**1.0*c*** (to the right)	**1.5*c*** (to the right)

2) A crew of astronauts is traveling from planet Earth to the planet Krypton to study an extinct race of super-powerful beings. In the Earth/Krypton reference frame, Earth and Krypton are 20 lt-y apart. The spaceship travels at a speed 0.8*c* relative to the Earth (and Krypton)

a) How long does the trip take according to someone on the Earth?

b) How long does the trip take according to the astronauts?

3) According to passengers sitting on a train, the train is 125 m long. The train is moving over a bridge at constant speed. According to construction workers standing on the bridge, the train is 100 m long. Determine the speed of the train with respect to the workers.

4) According to Eva Green, Gooey the duck is flying towards her at constant speed. Eva throws a stick towards Gooey at constant speed $0.6c$ relative to Eva. Relative to Gooey, the stick moves towards him at constant speed $0.8c$. Determine Gooey's speed with respect to Eva.