Problem 9.18. An observer in reference frame $S$ measures two events as simultaneous. Event $A$ occurs at the point $(50.0 \, \text{m}, 0, 0)$ at the instant 9:00:00 Universal time on January 15, 2005. Event $B$ occurs at the point $(150 \, \text{m}, 0, 0)$ at the same moment. A second observer, moving past with a velocity of $0.800c \hat{i}$, also observes the two events. In her reference frame $S'$, which event occurred first and what time interval elapsed between the events?

Problem 9.19. A red light flashes at position $x_R = 3.00 \, \text{m}$ and time $t_R = 1.00 \cdot 10^{-9} \, \text{s}$, and a blue light flashes at $x_B = 5.00 \, \text{m}$ and $t_B = 9.00 \cdot 10^{-9} \, \text{s}$, all measured in the $S$ reference frame. Reference frame $S'$ has its origin at the same point as $S$ at $t = t' = 0$; frame $S'$ moves uniformly to the right. Both flashes occur at the same place in $S'$. (a) Find the relative speed between $S$ and $S'$. (b) Find the location of the two flashes in frame $S'$. (c) At what time does the red flash occur in the $S'$ frame?

Problem 9.22. A spacecraft is launched from the surface of the Earth with a velocity of $0.600 \, c$ at an angle of $50.0^\circ$ above the horizontal positive $x$ axis. Another spacecraft is moving past with a velocity of $0.700c$ in the negative $x$ direction. Determine the magnitude and direction of the velocity of the first spacecraft as measured by the pilot of the second spacecraft.

Problem 9.50. Ted and Mary are playing a game of catch in frame $S'$, which is moving at $0.600 \, c$ with respect to frame $S$, while Jim, at rest in frame $S$, watches the action (Fig. P9.50). Ted throws the ball to Mary at $0.800c$ (according to Ted), and their separation (measured in $S'$) is $1.80 \cdot 10^{12} \, \text{m}$. (a) According to Mary, how fast is the ball moving? (b) According to Mary, how long does the ball take to reach her? (c) According to Jim, how far apart are Ted and Mary, and how fast is the ball moving? (d) According to Jim, how long does it take the ball to reach Mary?

Problem 9.V12. The $S'$ frame moves along the $x$ axis of the $S$ frame with a constant velocity $v$. Observers in $S$ see an event $A$ occurring at $x_1 = 0$ at time $t_1 = 0$ and another event $B$ at $x_2 = 1.5 \, \text{km}$ at time $t_2 = 2.7 \, \mu \text{s}$. In the $S'$ frame, the two events are simultaneous. (a) Find $v$. (b) For which $v$ between the two frames will the event $B$ precede the event $A$ for observers in the $S'$ frame?