In this problem you are to use the approximation that the speed of light is 0.3 meters per nanosecond.

Recall that the Lorentz transformations are

$$\Delta x' = \gamma (\Delta x - \beta c \Delta t) \quad \text{and} \quad \Delta t' = \gamma (\Delta t - \beta \Delta x/c)$$
where \( \beta \equiv v/c \) and \( \gamma \equiv \left(1 - \beta^2\right)^{-1/2} \).

\( \beta \) describes the motion of the primed coordinate axes relative to the unprimed frame.

A relativistic spaceship with rest length 100 meters is traveling above the surface of the moon, moving to the right at speed 0.8c, as shown in the figure. Two objects, labeled 1 and 2 in the figure, are separated along the direction of travel of the spaceship by 500 meters as measured in the rest frame of the moon. (Note that lengths are not drawn to scale in the figure.)

At time \( t = t' = 0 \) the spaceship grabs Object 1 with a manipulator located at the rear of the ship as it passes above the object. A short time later the spaceship grabs Object 2 with a manipulator located at the front of the ship.

(a) Calculate the time interval between when the two objects are grabbed, as measured in the rest frame of the spaceship.

(b) Calculate the time interval between when the two objects are grabbed, as measured in the rest frame of the moon.

(c) Draw a pair of world-line diagrams that show the space-time trajectories of the manipulators and objects. One diagram should correspond to the rest frame of the moon, the other the rest frame of the spaceship. (Please label the axes \( x \) and \( ct \) for one graph and \( x' \) and \( ct' \) for the other.) Indicate clearly the space-time points at which the objects are grabbed by the manipulators.