

15. The proper time is not measured by clocks in either frame S or frame S' since a single clock at rest in either frame cannot be present at the origin and at the event. The full Lorentz transformation must be used:

$$x' = \gamma(x - vt) \quad \text{and} \quad t' = \gamma(t - \beta x/c)$$

where $\beta = v/c = 0.950$ and $\gamma = 1/\sqrt{1 - \beta^2} = 1/\sqrt{1 - (0.950)^2} = 3.20256$. Thus,

$$\begin{aligned} x' &= (3.20256) (100 \times 10^3 \text{ m} - (0.950)(2.998 \times 10^8 \text{ m/s})(200 \times 10^{-6} \text{ s})) \\ &= 1.38 \times 10^5 \text{ m} = 138 \text{ km} \end{aligned}$$

and

$$t' = (3.20256) \left[200 \times 10^{-6} \text{ s} - \frac{(0.950)(100 \times 10^3 \text{ m})}{2.998 \times 10^8 \text{ m/s}} \right] = -3.74 \times 10^{-4} \text{ s} = -374 \mu\text{s} .$$