

# SOLUTION

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|-------------|----------------------|
| NAME: _____ | Quiz #8b:<br>Phys270 |
| _____       | Section 0104         |

2. [10 pts] Two events in reference frame S occur 20  $\mu$ s apart at the same point in space. The distance between the two events is 2000 m in reference frame S'.

[Note that 1  $\mu$ s is  $10^{-6}$  sec and the speed of light is  $c = 3.0 \times 10^8$  m/s]

- a. What is the time interval between the events in reference frame S'?

$$(\Delta x)^2 - c^2(\Delta t)^2 = (\Delta x')^2 - c^2(\Delta t')^2 \quad [\text{conserving spacetime interval between the 2 events}]$$

$$0^2 - c^2(20\mu s)^2 = (2000)^2 - c^2(\Delta t')^2$$

$$(\Delta t')^2 = \frac{(2000)^2}{c^2} + (20\mu s)^2$$

$$\Delta t' = \left[ \left( \frac{2 \times 10^3}{3 \times 10^8} \right)^2 + (20\mu s)^2 \right]^{1/2} = \left[ (6.66\mu s)^2 + (20\mu s)^2 \right]^{1/2}$$

$$= 21.08\mu s$$

- b. What is the velocity of S' relative to S?

we have

$$21.08\mu s = \Delta t'$$

$$\Delta t' = \gamma \Delta t \quad [\text{using time dilation}]$$

$$21.08 = \frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{1/2}} 20$$

$v = \text{velocity of S' w.r.t S}$

$$\Rightarrow 1 - \frac{v^2}{c^2} = \left( \frac{20}{21.08} \right)^2$$

$$\therefore v/c = \left[ 1 - \left( \frac{20}{21.08} \right)^2 \right]^{1/2}$$

$$\therefore v = 0.316c$$

Ans.  $v = 0.316c$