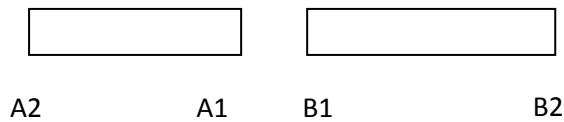


Solution to Relativity Tutorial Q 11

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11) Define Events as follows



E1: Ends A1 and B1 coincide

E2: Ends A2 and B2 coincide

$$V_a = 0.6c \quad V_b = 0.8c \quad \gamma_a = 5/4 \quad \gamma_b = 5/3$$

In the ground frame the lengths would appear to be contracted as

$$L_a = l_0 / \gamma_a = 4\text{m} \quad L_b = l_0 / \gamma_b = 3\text{m}$$

a) Let time in S frame = t

$$(0.6c)t + (0.8c)t = L_a + L_b = 7\text{m}$$

$$\Delta t = 1.67 \times 10^{-8} \text{ s}$$

b) Let A1 and B1 coincide at t=0 in S frame

In $t = 1.67 \times 10^{-8} \text{ s}$, end A2 moves by
 $(0.6c) \times 1.67 \times 10^{-8} \text{ s} = 3\text{m}$ in + X direction

And end B2 moves by
 $(0.8c) \times 1.67 \times 10^{-8} \text{ s} = 4\text{m}$ in – X direction

Therefore $\Delta x = -1 \text{ m}$

Apply Lorentz Transformation,

$$\Delta t' = \gamma(\Delta t - \Delta x v / c^2)$$

$$\Delta t' = 1.25 * (1.67 \times 10^{-8} - (-1) * (0.6c) / c^2)$$

$$\Delta t' = 2.33 \times 10^{-8} \text{ s}$$

c) Similarly (as in part b)

$$\Delta t'' = \gamma(\Delta t - \Delta x v / c^2)$$

$$\Delta t'' = 2.33 \times 10^{-8} \text{ s}$$

d) Least possible time is the proper time

$$\Delta \tau^2 = \Delta t^2 - (\Delta x^2 + \Delta y^2 + \Delta z^2) / c^2$$

Substitute $\Delta t = 1.67 \times 10^{-8} \text{ s}$ and $\Delta x = -1 \text{ m}$

$$\Delta \tau = 1.63 \times 10^{-8} \text{ s}$$

e) The frame in which the time is the least would have

$$\Delta x''' = \gamma(\Delta x - v \Delta t) = 0$$

Therefore,

$$v = \Delta x / \Delta t = (-1) / 1.63 \times 10^{-8} \text{ s}$$

$$v = -0.2c$$