

Print Your Last Name: \_\_\_\_\_

First name: Solution aShow detailed work to receive full scores. ( $c = 300 \text{ m}/\mu\text{s}$ )*Giving or receiving aid is cause for dismissal from the university.*

EVENT 0: The ground manager  $\mathcal{O}$  ( $x = 0$ ) of the unprimed coordinate system ( $x, t$ ) coincides with the train conductor  $\mathcal{O}'$  ( $x' = 0$ ) of the primed coordinate system ( $x', t'$ ) when  $t = 0, t' = 0$ . The train moves at  $v = 0.6c$  w.r.t. the ground.

EVENT 1: At  $t = t_1 = 2\mu\text{s}$  ( $\mu$  means  $10^{-6}$ ), the manager  $\mathcal{O}$  shoots a light signal aiming at the conductor  $\mathcal{O}'$ .

At this very moment, where is the train conductor in terms of the unprimed position  $x$  of (in meter)?

$$x = vt_1 = 0.6 \times 300 \times 2 = 360 \text{ m.}$$

EVENT 2: The light zaps the conductor. At what time  $t_2$  (in  $\mu\text{s}$  of the unprimed system) does it happen? And at what unprimed position  $x_2$  (in m)? (Use simple arithmetic, as in the example of Tom meeting Mary)

$$ct = vt + 360; \quad t = \frac{360}{c-v} = \frac{360}{0.4c} = \frac{360}{0.4 \times 300} = 3\mu\text{s}$$

$$t_2 = 2\mu\text{s} + 3\mu\text{s} = 5\mu\text{s}$$

$$x_2 = vt_2 = (0.6c)(5\mu\text{s}) = 0.6 \times 300 \times 5 = 900 \text{ m.}$$

At what time  $t'_2$  (in  $\mu\text{s}$  of the primed system)?

$$t'_2 (\text{proper}) = \sqrt{1-(0.6)^2} t_2 = (0.8) 5\mu\text{s} = 4\mu\text{s}$$

Being zapped, the conductor immediately revenges by sending a light toward  $\mathcal{O}$ .

EVENT 3: The manager gets zapped. At what unprimed time  $t_3$ ? What primed time  $t'_3$ ?

$$t = \frac{900 \text{ m}}{c} = \frac{900}{300} = 3\mu\text{s}$$

$$t_3 = 3\mu\text{s} + 5\mu\text{s} = 8\mu\text{s}$$

$$t'_3 = \frac{8\mu\text{s}}{\sqrt{1-0.6^2}} = \underline{\underline{10\mu\text{s}}}$$

self consistent:

$x'_3$  of  $\mathcal{O}$  in the primed coord.

$$x'_3 = -4\mu\text{s} \times 0.6c = -720 \text{ m.}$$

$$t'_3 = \frac{720 \text{ m}}{c-0.6c} + 4\mu\text{s} = \frac{720}{0.4 \cdot 300} + 4 = 10\mu\text{s.}$$

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Solution bShow detailed work to receive full scores. ( $c = 300 \text{ m}/\mu\text{s}$ )*Giving or receiving aid is cause for dismissal from the university.*

EVENT 0: The ground manager  $O$  ( $x = 0$ ) of the unprimed coordinate system ( $x, t$ ) coincides with the train conductor  $O'$  ( $x' = 0$ ) of the primed coordinate system ( $x', t'$ ) when  $t = 0, t' = 0$ . The train moves at  $v = 0.8c$  w.r.t. the ground.

EVENT 1: At  $t = t_1 = 3\mu\text{s}$  ( $\mu$  means  $10^{-6}$ ), the manager  $O$  shoots a light signal aiming at the conductor  $O'$ .

At this very moment, where is the train conductor in terms of the unprimed position  $x$  of (in meter)?

$$x = vt_1 = (0.8 \times 300) \times 3\mu\text{s} = 720 \text{ m}$$

EVENT 2: The light zaps the conductor. At what time  $t_2$  (in  $\mu\text{s}$  of the unprimed system) does it happen? And at what unprimed position  $x_2$  (in m)? (Use simple arithmetic, as in the example of Tom meeting Mary)

$$ct = vt + 720; \quad t = \frac{720}{c - 0.8c} = \frac{720}{0.2 \times 300} = 12\mu\text{s}$$

$$t_2 = 12\mu\text{s} + 3\mu\text{s} = \underline{15\mu\text{s}}$$

$$x_2 = vt_2 = (0.8 \times 300) \times 15 = 3600 \text{ m.}$$

At what time  $t'_2$  (in  $\mu\text{s}$  of the primed system)?

$$t'_2 (\text{proper}) = \sqrt{1 - 0.8^2} \cdot t_2 = 0.6 \times 15 = \underline{9\mu\text{s}}$$

Being zapped, the conductor immediately revenges by sending a light toward  $O$ .

EVENT 3: The manager gets zapped. At what unprimed time  $t_3$ ? What primed time  $t'_3$ ?

$$t = \frac{3600}{300} = 12\mu\text{s}$$

$$t_3 = 12 + 15 = 27\mu\text{s}$$

$$t'_3 = \frac{27}{\sqrt{1 - 0.8^2}} = \frac{27}{0.6} = 45\mu\text{s}$$

Consistency check

$x'_3$  of  $O$  in the primed coord.

$$x'_3 = -9\mu\text{s} \cdot (0.8 \times 300) = -2160 \text{ m}$$

$$t'_3 = \frac{2160}{0.2 \times 300} + 9 = 36 + 9 = 45\mu\text{s}$$

agree