

Homework 1

Problem 1

For constant velocity we have

$$d = ct = 4.4 \cdot 10^{12} \text{m.}$$

Problem 2

Its clear that (where wrt \equiv with respect to)

$$v_{\text{train wrt earth}} = v_{\text{train wrt bike}} + v_{\text{bike wrt earth}}$$

and rearranging we obtain,

$$\begin{aligned} v_{\text{bike wrt train}} &= -v_{\text{train wrt bike}} = -v_{\text{train wrt earth}} + v_{\text{bike wrt earth}} \\ &= -10 \text{m/s} + 2 \text{m/s} = -8 \text{m/s.} \end{aligned}$$

Problem 3

According to Newton, and from problem 2 we have

$$v_{\text{bike wrt train}} = -v_{\text{train wrt earth}} + v_{\text{bike wrt earth}} = -v + c$$

which would be positive since $v < c$. If $v = c$ then the pulse is stationary.

Problem 4

The spacetime interval is

$$\Delta s = \sqrt{c^2 \Delta t^2 - \Delta x^2} = 3.0 \cdot 10^8 \text{m.}$$

The proper time is

$$\Delta \tau = \frac{\Delta s}{c} = 1 \text{s.}$$

The spacetime interval is invariant thus

$$\Delta s' = \Delta s = 1 \text{m.}$$

Problem 5

Using Δx from problem 4, the spactime interval is

$$\Delta s = 2.8\text{m}.$$

The proper time is

$$\Delta\tau = \frac{\Delta s}{c} = 9.3 \cdot 10^{-9}\text{s}.$$

The speed is simply

$$v = \frac{d}{t} = 10^8\text{m/s}.$$