

HW #2 4-6, 4-7, 5-6, 5-9, 6-6, 6-9, 7-2, 7-7

4-6) a) use time dilation formula

$$t = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$t = \frac{2.5 \times 10^{-9}}{\sqrt{1 - 0}} = 2.5 \times 10^{-9} \text{ s (at rest)}$$

$$b) t = \frac{2.5 \times 10^{-9}}{1 - \left(\frac{4}{5}\right)^2} = 4.16 \times 10^{-9} \text{ s}$$

$$4-7) a) t = \frac{d}{\text{speed}} = \frac{20}{\frac{1}{5}} = \frac{100}{5} \text{ years}$$

$$b) t = \frac{100}{5} \sqrt{1 - \left(\frac{4}{5}\right)^2} = \frac{100}{5} \left(\frac{3}{5}\right) = \frac{80}{5} \text{ years}$$

$$c) t = \frac{80}{5} \sqrt{1 - \left(\frac{3}{5}\right)^2} = \frac{80}{5} \left(\frac{4}{5}\right) = \frac{64}{5} \text{ years}$$

$$5-4) a) v_3 = c \sqrt{1 - \left(\frac{12.5}{25}\right)^2} = c \sqrt{\frac{3}{4}}$$

$$b) t = \frac{12.5}{\frac{\sqrt{3}}{2}} = 14$$

$$5-9) \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\sqrt{1 - \frac{v^2}{c^2}} = \frac{1}{\gamma}$$

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

$$\frac{v}{c} = \sqrt{1 - \left(\frac{1}{\gamma}\right)^2}$$

$$\frac{v}{c} = 1 - \frac{1}{\gamma^2}$$

$$\epsilon = 10 \times 10^{-10}$$

$$b) \ell = L \sqrt{1 - \left(\frac{v}{c}\right)^2}$$

$$\frac{v}{c} = \sqrt{1 - \left(\frac{\ell}{L}\right)^2}$$

$$1 - \epsilon = 1 + \frac{1}{2} \left(-\frac{\ell}{L}\right)^2$$

$$4 \times 10^{-11}$$

6-5) a) the rod is moving along the x-axis,

$$b) \tan \theta = \frac{\Delta y}{\Delta x}$$

$$\theta = \tan^{-1} \left(\frac{v' \Delta y}{c^2 \Delta x \sqrt{1 - \left(\frac{v}{c}\right)^2}} \right) = \tan^{-1} \left(\frac{v' v}{c^2 \sqrt{1 - \left(\frac{v}{c}\right)^2}} \right)$$

$$6-9) L = \frac{\Delta x'}{\Delta t'}$$

$$\Delta t' = \frac{\Delta x'}{c} = \frac{L \sqrt{1 - \left(\frac{v}{c}\right)^2}}{c}$$

$$\Delta t' = \frac{L \sqrt{1 - \left(\frac{v}{c}\right)^2}}{c}$$

$$7-2) a) \Delta t_{A_1} = \frac{1}{\sqrt{1 - \left(\frac{24}{25}\right)^2}}$$

$$\Delta t_{A_1} = 25 \text{ years}$$

$$\underset{\substack{\uparrow \\ \text{given}}}{18} + 25 = 43 \text{ years old (AI)}$$

$$b) D = \left(\frac{24}{25}\right) \left(\frac{25}{2}\right) = 12 \text{ years}$$

7-7) The stick goes through the hole
 Since each sequence falls at different times