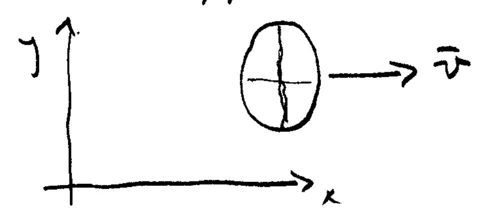
Ph 203

Question Chapt 1

2. The diameter of the spherical spaceship would be contracted in the direction of motion. So to the unmoving observer, the ship would appear to be elliptical.



3. The astronaut appears to be compressed in the direction of his/her motion. The pulse rate measured by the observer on the Earth is slower, since time intervals appear dilated. The astronaut would not measure any changes in him/her self.

Question chapt 1

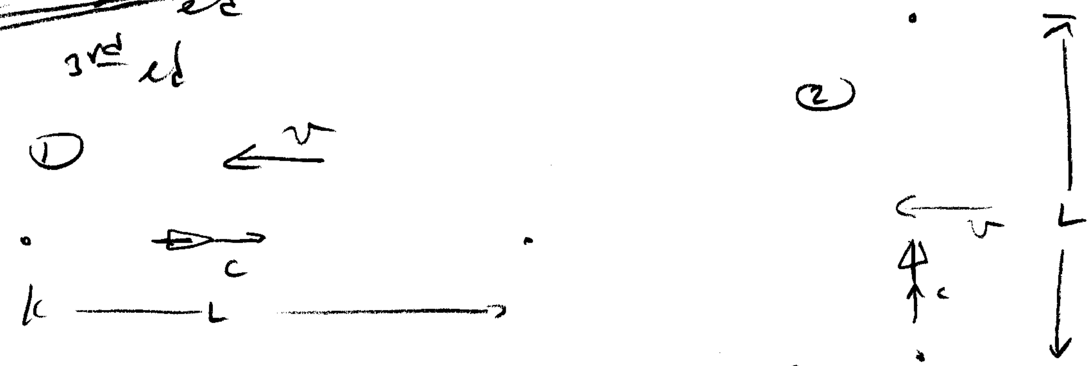
Ph 207

6. To say a moving clock runs slower than a stationary clock do not imply anything physically ~~un~~ usual.

7. This is a fake question. Time intervals measured in different inertial reference frames may be different. I guess this means time passes at different rates.

~~1-5 2nd ed~~

1-4 3rd ed



$$t_1 = \frac{L}{c+v} + \frac{L}{c-v} = \frac{2L}{c}\left(1-\frac{v^2}{c^2}\right)^{-1} = \boxed{0.417\ h}$$

$$t_2 = \frac{2L}{(c^2-v^2)^{1/2}} = \frac{2L}{c}\left(1-\frac{v^2}{c^2}\right)^{-1/2} = \boxed{0.408\ h}$$

$$\Delta t = \frac{2L}{c}\left[\left(1-\frac{v^2}{c^2}\right)^{-1} - \left(1-\frac{v^2}{c^2}\right)^{-1/2}\right] =$$

$L = 100$ mile $\quad c = 500$ mi/h $\quad v = 100$ mi/h

$$\frac{v^2}{c^2} = 0.04 \ ; \quad 1-\frac{v^2}{c^2} = 0.96$$

$$\left[\left(1-\frac{v^2}{c^2}\right)^{-1} - \left(1-\frac{v^2}{c^2}\right)^{-1/2}\right] = 0.021$$

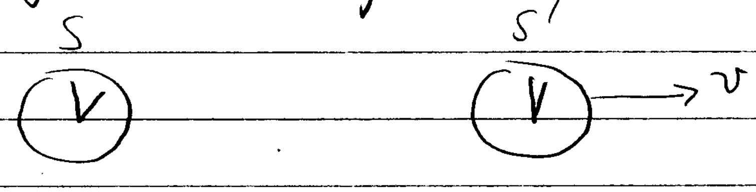
$$\Delta t = \frac{2L}{c}(0.021)$$

$$\Delta t = \frac{2(100\ \text{mi})}{500\ \text{mi/h}}\ .021$$

$$\boxed{\Delta t = 0.0084\ hr}$$

1.5 3rd ed

1.6 One clock is at rest (relative to us) while a second clock moves at a constant speed, v. The moving clock runs at $\frac{1}{2}$ the rate of the resting clock.



That is, we are given that time intervals measured in the two frames are related by

$$\Delta t = 2\Delta t'$$

According to the time dilation equation

$$\Delta t = \frac{\Delta t'}{\sqrt{1-\frac{v^2}{c^2}}}$$ We need to solve for v.

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

$$v^2 = \left[1-\left(\frac{\Delta t'}{\Delta t}\right)^2\right]c^2 \qquad \text{Set } \frac{\Delta t'}{\Delta t} = \frac{1}{2}$$

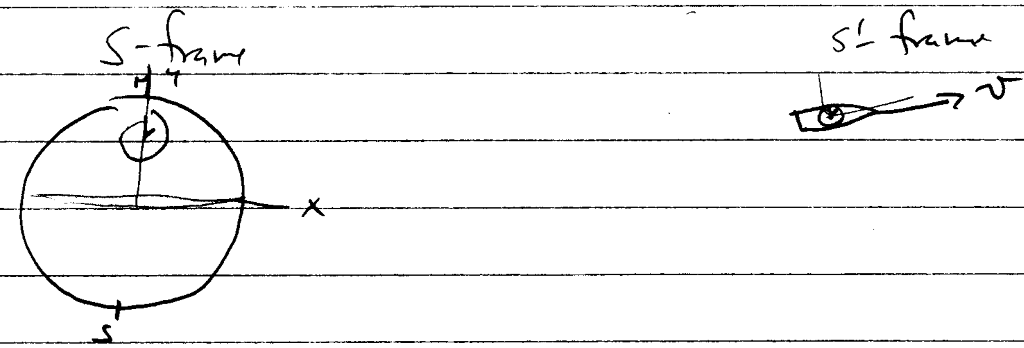
$$v^2 = \left(1-\frac{1}{4}\right)c^2$$

$$v = \frac{\sqrt{3}}{2}c$$

The moving clock is moving with a speed $\frac{\sqrt{3}}{2}c$.

1.7 3rd ed

~~1.8~~



The spacecraft moves with speed v relative to the Earth, where $v << c$.
The clock in the S'-frame runs just slightly slower than a clock in the S-frame

$$\frac{\Delta t'}{\Delta t} = \frac{24h - 1sec}{24h} = \frac{(86400-1)\,sec}{86400\,sec} = 0.99999$$

According to "time dilation"

$$\Delta t = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\,\Delta t' \quad \text{or}$$

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

Since $v << c$, we approximate $\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}}$ by the first two terms of the binomial expansion

$$\Delta t = \left(1+\frac{v^2}{2c^2}\right) \Delta t' \qquad \text{Now solve for } v$$

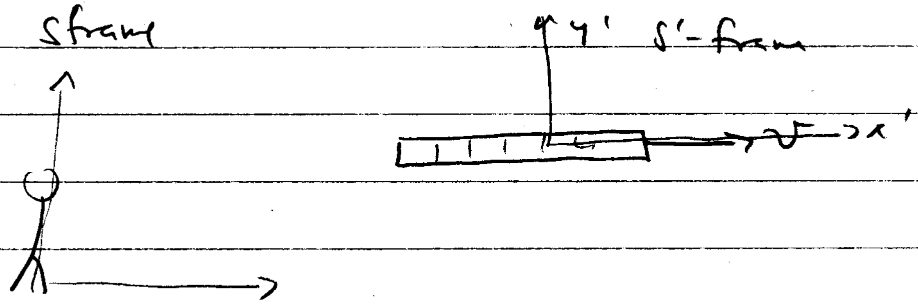
$$\frac{\Delta t}{\Delta t'} = 1 - \frac{v^2}{2c^2}$$

$$v^2 = \left(1.00001 - 1\right) 2c^2 = .$$

$$v = 0.0045c$$

1.8 3rd ed

~~L9~~



The proper length of the meter stick is $l_0 = 1\,m$.
The length measured in the S-frame is
$l = 0.75\, l_0$. We want to solve for v.

Length contraction formula:

$$l_0 = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\, l \quad , \text{ solve for } v$$

$$\sqrt{1-\frac{v^2}{c^2}} = \frac{l}{l_0}$$

$$v^2 = -\left[\left(\frac{l}{l_0}\right)^2 - 1\right] c^2$$

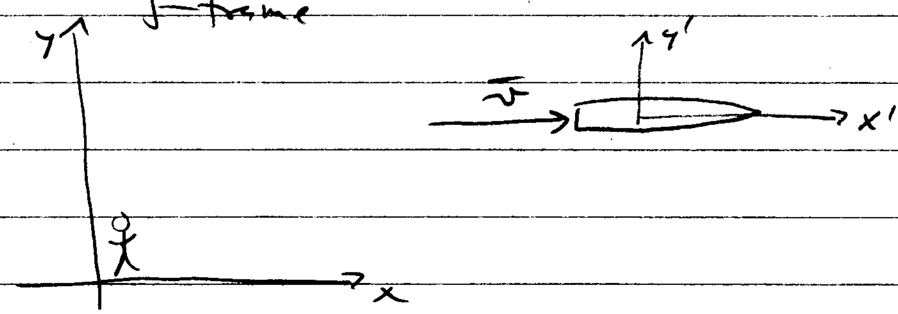
Plug in $\frac{l}{l_0} = 0.75$

$$v^2 = -\left(0.75^{-2} - 1\right) c^2$$

$$v = 0.661c$$

1,9 3rd ed

~~1.10~~



Again, the proper length is $l_0 = L$. The speed relative to the S-frame is $v = 0.900c$. The measured length in the S-frame is

$$l = \sqrt{1-\frac{v^2}{c^2}}\; l_0$$

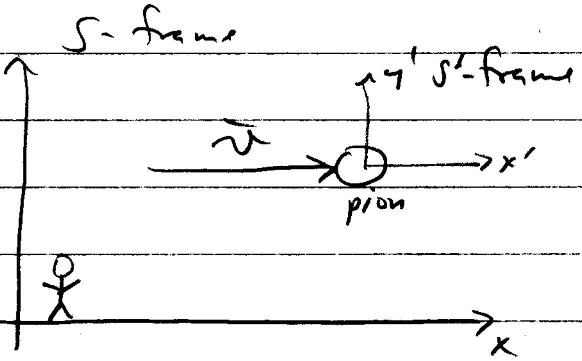
Plug in $v = 0.900c$; and $l_0 = L$; compute

$$l = \sqrt{1-(.900)^2}\; L = 0.436\, L$$

1.10 3rd ed

~~1.11~~

Phys 203



The pion's proper life time is $\Delta t' = 2.6 \times 10^{-8}$ sec.
The pion's speed in the S-frame is $v = 0.95c$.

a) The lifetime observed in the S-frame is

$$\Delta t = \frac{\Delta t'}{\sqrt{1 - \frac{v^2}{c^2}}}$$, plug in v + $\Delta t'$,

$$\Delta t = \frac{2.6 \times 10^{-8} \text{ sec}}{\sqrt{1 - (.95^2)}} = 8.3 \times 10^{-8} \text{ sec}$$

b) In the S frame, the pion is observed to travel a distance

$d = v \Delta t$

$d = 0.95c \cdot 8.3 \times 10^{-8}$ sec

$d = 24$ m