1-4 In this problem the "trick" is to repeatedly use invariance of the interval. The flashes always occur at the same spot in the rocket frame. So the interval^2 can be calculated from the rocket time lapse squared.

It can also be calculated from the laboratory time lapse^2 − laboratory distance^2

a. $\text{interval}^2 = ?^2$

$\text{interval}^2 = 10.72^2 - 5.95^2$

$\Rightarrow \quad ? = \sqrt{10.72^2 - 5.95^2}$

$= 8.91$ seconds

all inputs in seconds and light-seconds

b. $\text{interval}^2 = 20^2$

$\text{interval}^2 = ?^2 - 99^2$

$\Rightarrow \quad ? = \sqrt{20^2 + 99^2}$

$= 101$ seconds

→ all results in seconds and light-seconds

c. $\text{interval}^2 = 66.8^2$

$\text{interval}^2 = 72.9^2 - ?^2$

$\Rightarrow \quad ? = \sqrt{72.9^2 - 66.8^2}$

$= 29.19$ light-seconds

d. Like a. $? = \sqrt{8.34^2 - 6.58^2} = 5.12$ s

e. Like c. $? = \sqrt{22^2 - 21^2} = 6.56$ light-seconds

1-8 a. $\frac{1}{2} \frac{1}{1{,}000{,}000/s} 3\times10^8 \frac{m}{s} = 1.5\times10^2 m$

150 meters!

Maximum size is decreased to 75 meters if the conductors conduct at $\frac{1}{2}c$.

b. Same as a, but reduced by 1000.

$\Rightarrow$ 75 mm or 7.5 cm.

c. 75 μm ← "micron" ← more common term

or micrometer

d. Some fraction of the operations require coordination between processors. If every 10,000 operations on a 1 teraflop machine requires coordination, then every $\frac{10{,}000}{10^{12}/s} = 10^{-8}s$ it has to coordinate. In that case, it could be 75 cm. With those numbers the coordination takes all the time. Let the coordination take half the time. The machine can be 37.5 cm. The other half the time you net $\frac{1}{2}$ teraflop of computing capability.

1–10 a. Not at all. The transporter reconstitutes you without aging you.

b. One year. Her only aging occurs on Zircon.

c. 4,000,001 years.

d. At least 4,000,000 years (plus how long it takes the warriors to either win or lose).

e. The "careful" in this part really means "don't get too fancy." If the transporternaut spends what is apparently (to her) one year moving with the galaxy then she is simply one year older when reconstituted back on Earth.

1–12 a. We are told not to worry about time stretching. Half will get to

18×10^{-9} seconds $\times 3 \times 10^{8} \frac{m}{s} = 5.4$ meters

b.

time in lab	distance in lab
time in meson frame	distance in meson frame

setup cont'd on next page

1-12 b. (cont'd) $v = 0.9978$ $\tau = 18 \times 10^{-9}$ s

x/v	x
τ	0

$$\frac{x^2}{v^2} - x^2 = \text{interval}^2$$

$$\tau^2 - 0^2 = \text{interval}^2$$

$$\Longrightarrow \frac{x^2}{v^2} - x^2 = \tau^2$$

$$\Longrightarrow x = \frac{\tau}{\sqrt{\frac{1}{v^2} - 1}} = \frac{5.4\,\text{m}}{\sqrt{\frac{1}{0.9978^2} - 1}}$$

or 5.4 m if we use the magic units

$= 81$ meters

Notice that I didn't use any fancy formulas to solve 1-12 b. Just invariance of the interval!