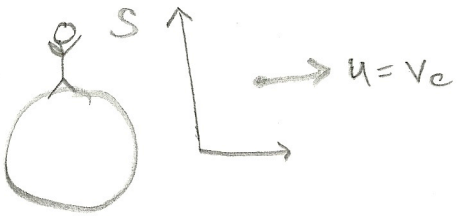
Quiz 1 (you were not graded on sig. figs.

1. A. 

$V_s = .45c$ $V_c = .8c$ s' = shuttle's perspective



want to know what speed the space craft observer measures, u'_c

$$u'_c = \frac{u_c - V}{1 - \frac{u_c V}{c^2}} = \frac{.8c - .45c}{1 - \frac{(.8c)(.45c)}{c^2}} = \boxed{0.55c}$$

B. The observer in the spacecraft sees the comet move at 0.55c relative to his own rest frame. He measures the comet's tail to be 1000 meters, ~~but he~~ is not measuring the proper length. Since he + the comet are moving relative to one another, the comet's tail looks contracted.

$$L = 1000 \text{ meter} = \frac{L_p}{\gamma}$$

$$\Rightarrow L_p = 1000 \text{m} \gamma = \frac{1000 \text{ m}}{\sqrt{1 - \frac{(.55c)^2}{c^2}}} = \boxed{1197 \text{ meters}}$$

2. A. Time = distance/velocity = $\frac{4 \text{ ~~light~~years}}{(.99 \times 1 \text{ ~~light~~year/year})}$

= 4.04 years according to astrophysicist

B. can use time dilation or length contraction.

- Since the astronaut is measuring the time it takes for his reference frame to leave earth and reach the star, he is measuring proper time

$$T = T_p\gamma \Rightarrow T_p = T/\gamma = (4.04\text{ yrs})\sqrt{1-\frac{(.99c)^2}{c^2}} = \boxed{0.57\text{ yrs}}$$

Using length contraction, the astronaut sees himself traveling @ .99c away from earth, but the distance to the star looks shorter

$$L = \frac{L_p}{\gamma} = (4\text{ light years})\left(\sqrt{1-\frac{(.99c)^2}{c^2}}\right) = 0.564\text{ light years}$$

so the time it takes him $t = \frac{\text{distance}}{\text{speed}} = \frac{0.564\text{ light years}}{.99\text{ light years/year}}$

$$\boxed{= 0.57\text{ years}}$$

C.

$$\lambda_{obs} = \lambda_{emitted}\left(\frac{\sqrt{1+(v/c)}}{\sqrt{1-(v/c)}}\right) = (500\text{ nm})\left(\frac{\sqrt{1+.99}}{\sqrt{1-.99}}\right)$$

$\boxed{\lambda_{obs} = 7050\text{ nm}}$ which is infared radiation. She could only see his laser if she had an infared telescope!

3. B the astronaut (see above)

4. B less than 1cm^3. As observer B moves relative to one of the die's edges, that dimension looks shorter, so the volume would be less than the "proper volume"