1a. $\mathcal{B} = (6, 9)$ all coordinates in <u>meters</u>

$\mathcal{A} = (-4, 3)$

t x

b. It goes $9-3$ meters in $6-(-4)$ meters

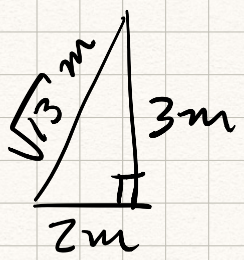
$$\frac{9-3}{6-(-4)} = \frac{6}{10} = \frac{3}{5}$$

c. $$\left((6-(-4))^2 - (9-3)^2\right) m^2 = (10^2 - 6^2)\, m^2$$

$$= (100-36)\, m^2 = 64\, m^2$$

d. $$\sqrt{64 m^2} = 8m$$

e. For a clock carried by the rocket, the two events occur at the same place (at the rocket). So the interval must just be due to the time difference $\Rightarrow$ the time difference according to a clock on the rocket is 8m.

2a. 

It does two hypotenuses of length $\sqrt{13}$ m in a round trip so the answer is $2\sqrt{13}$ m

b. The speed of light is 1 in convenient units, so the time is also

$$2\sqrt{13}\, m$$

c. $$\frac{4m \leftarrow \text{travel}}{2\sqrt{13}\, m \leftarrow \text{time}} \Rightarrow \frac{2}{\sqrt{13}}$$ is the speed of the mirrors

2d. Just 6m (transverse dimensions are not affected and the transverse dimension — which is traversed twice — is 3m)

e. Just 6m

I could have asked one more question....

f. How much longer (ratio) is the round trip in the lab frame than in the mirror frame?

$$\frac{2\sqrt{13}\,m}{6m} = \frac{\sqrt{13}}{3}$$

This better agree with the time dilation factor:

$$\frac{1}{\sqrt{1-v^2}} = \frac{1}{\sqrt{1-\left(\frac{2}{\sqrt{13}}\right)^2}} = \frac{1}{\sqrt{1-\frac{4}{13}}} = \frac{1}{\sqrt{\frac{9}{13}}} = \frac{\sqrt{13}}{3}$$

✓✓

3. $$\text{interval}^2 = t^2 - v^2t^2 = \tau^2 - 0^2$$

$$\Rightarrow (1-v^2)t^2 = \tau^2 \Rightarrow t = \frac{\tau}{\sqrt{1-v^2}}$$

4. Doppler Shift

a. Use $n = -\frac{1}{2}$ and $x = -(0.1)^2 = -0.01$

b. $$\frac{1}{\sqrt{1-0.1^2}}\,2s \approx \left(1 - \tfrac{1}{2}(-0.01)\right) 2s$$

$$= (1.005)\,2s = 2.010\,s$$

c. It is vt farther away which is

$$0.1 \cdot 2.010\,s = 0.201\,s \text{ farther away.}$$

SHOOT — 4 HAD A TYPO — I WANTED THREE DECIMAL PLACES. THAT GIVES AN ANSWER WITH 4 SIG FIGS.

d. The successive flashes are 2.010 s apart, but they have a successively increasing delay of 0.201 s, so they are received

$$2.010\,s + 0.201\,s = 2.211\,s \text{ apart.}$$

BTW, if you want to see how well our approximations did, put the general formula into a calculator:

$$\sqrt{\frac{1+0.1}{1-0.1}}\,2s = \sqrt{\frac{1.1}{0.9}}\,2s$$

$$= \boxed{2.211}08319357\ s$$

perfect

5a. $$\frac{0.5+0.5}{1+0.5\times0.5} = \frac{1}{1+\frac{1}{4}} = \frac{4}{5} = 0.8$$

6. $$\frac{0.5+1}{1+0.5\times1} = \frac{1.5}{1.5} = 1$$

and you don't even have to use the formula to know this — the speed of light is always 1.