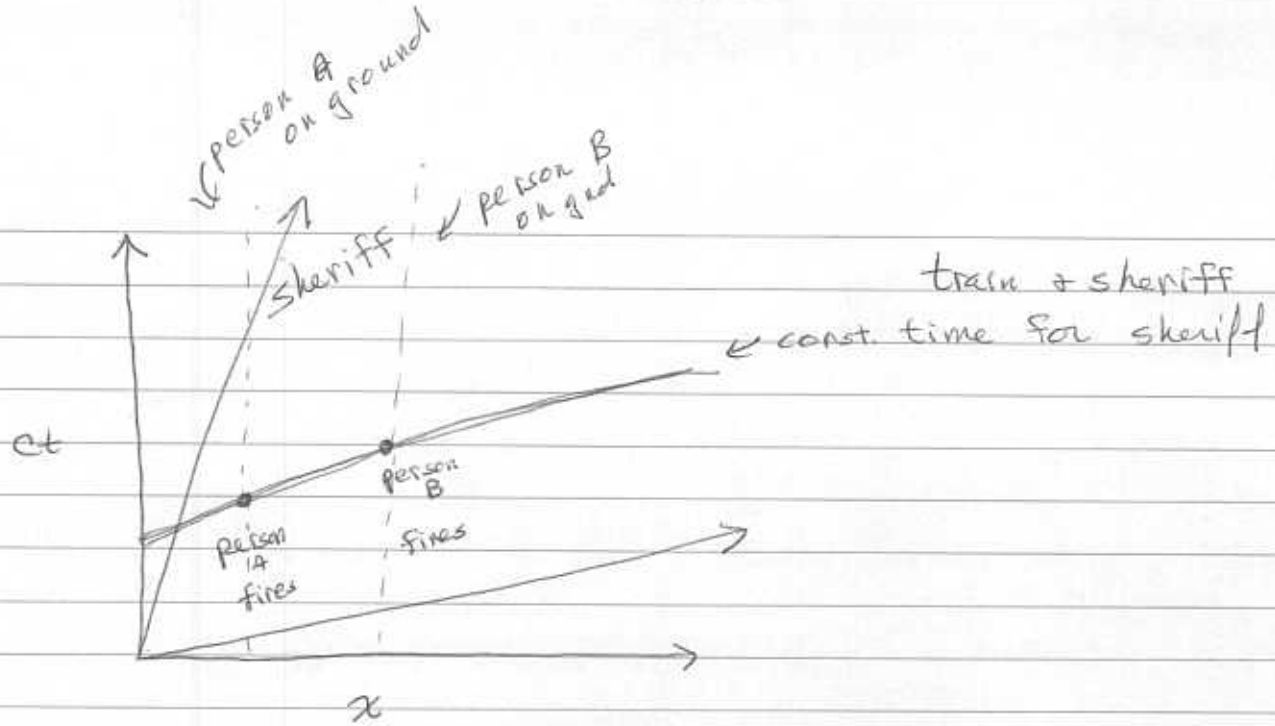
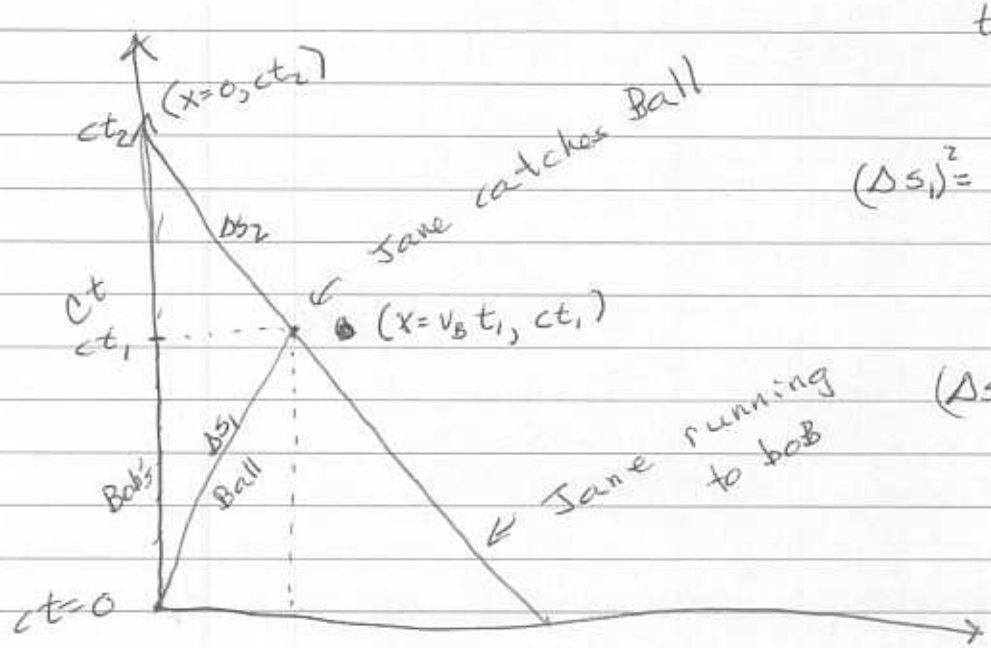


person A + B fire simultaneously in sheriff's frame.

in frame on ground, person A fires first. (1st person sheriff passes)



time passed for Ball: total Δs on path of Ball

$$(\Delta s_1)^2 = (ct_1 - 0)^2 - (v_{B\parallel} t_1 - 0)^2$$
$$= (c^2 - v_{B\parallel}^2)\, t_1^2$$
$$\Delta s_1 = c t_1 \sqrt{1 - v_{B\parallel}^2/c^2}$$

$$(\Delta s_2)^2 = (ct_2 - ct_1)^2 - (0 - v_{B\parallel} t_1)^2$$
$$= c^2 (t_2 - t_1)^2 - v_{B\parallel}^2 t_1^2$$
$$\Delta s_2 = c \sqrt{(t_2 - t_1)^2 - \frac{v_{B\parallel}^2}{c^2} t_1^2}$$

$$\text{total } \Delta s = \Delta s_1 + \Delta s_2 = c t_1 \sqrt{1 - v_{B\parallel}^2/c^2} + c \sqrt{(t_2 - t_1)^2 - \frac{v_{B\parallel}^2}{c^2} t_1^2}$$

time passed for ball is Δs on path$/c$

$$\text{time passed} = t_1\sqrt{1-\frac{V_{Ball}^2}{c^2}} + \sqrt{(t_2-t_1)^2 - \frac{V_{Ball}^2}{c^2}t_1^2}$$

You could also note that Jane travels from $x = V_{Ball}t_1$ to $x=0$ in time t_2-t_1 & that she is going with velocity v according to Bob:

so

$$V_{Ball}t_1 = v(t_2-t_1)$$

$$\text{or } (t_2-t_1) = \frac{V_{Ball}t_1}{v}$$

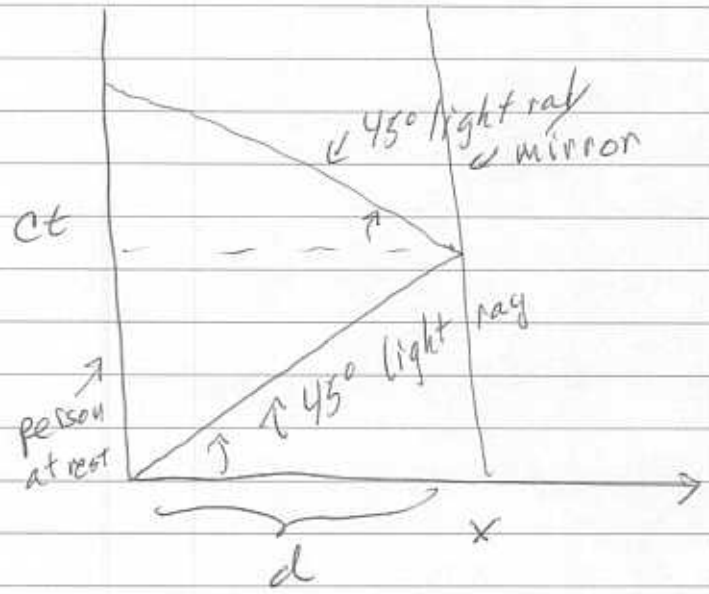
so that time passed =

$$t_1\sqrt{1-\frac{V_{Ball}^2}{c^2}} + \sqrt{t_1^2\frac{V_{Ball}^2}{v^2} - \frac{V_{Ball}^2}{c^2}t_1^2}$$

$$= t_1\sqrt{1-\frac{V_{Ball}^2}{c^2}} + t_1 V_{Ball}\sqrt{\frac{1}{v^2}-\frac{1}{c^2}}$$

But you don't need to do this rewriting.

Light ray & mirror



time elapsed for person:

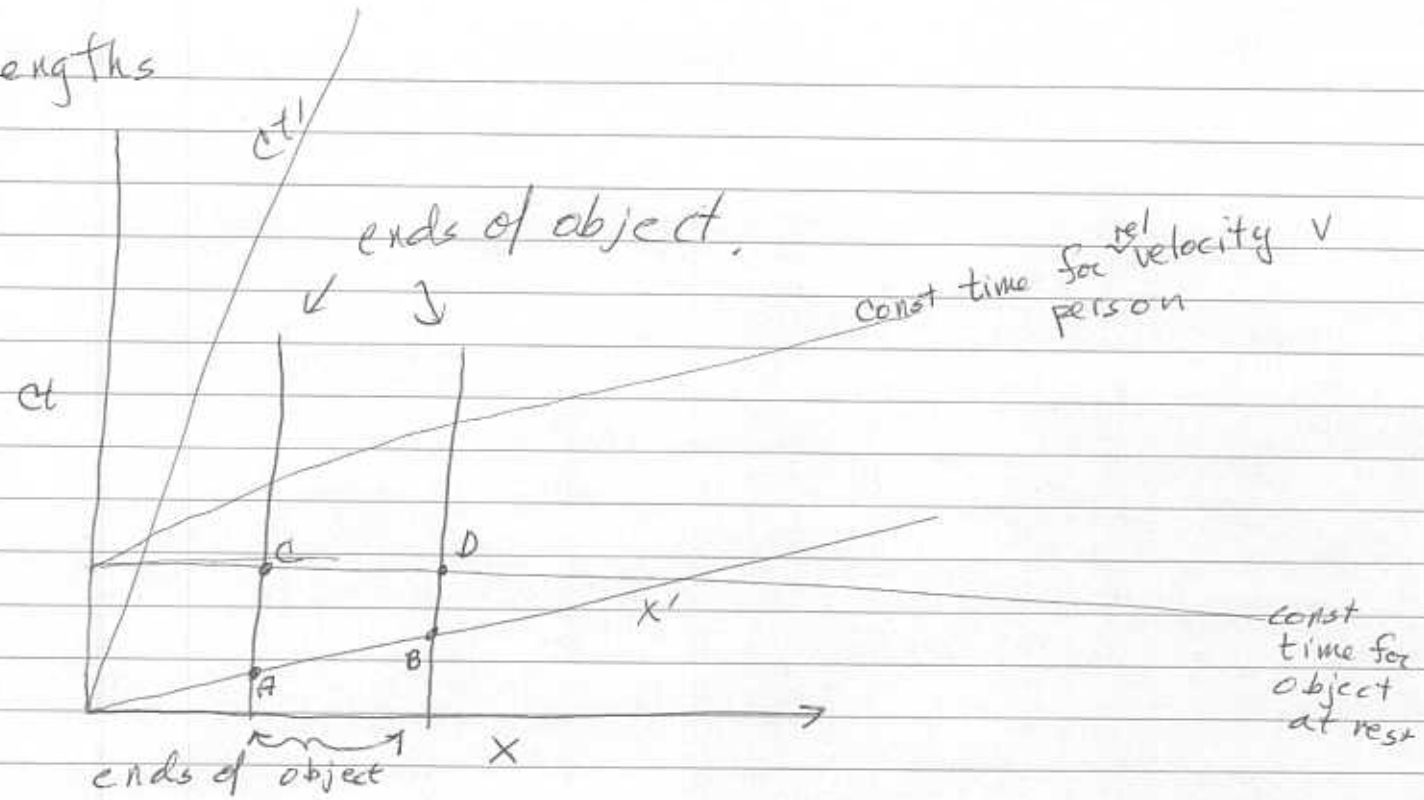
$$\Delta t = \frac{2d}{\text{vel}} = \frac{d}{c} + \frac{d}{c} = \frac{2d}{c}$$

time for light ray: on path

$$(\Delta s)^2 = (c\Delta t)^2 - (\Delta x)^2 = 0$$

so no time passed for light ray.

Lengths



x, ct rest frame of object
x', ct' frame w/rel. velocity v

length of segment A-B = length for person w/ vel. v rel to object.

length of segment C-D = length for person at rest wrt to object.

Point: length means distance between ends <u>at</u> <u>same</u> <u>time</u>.

Different observers - different idea of what <u>same</u> <u>time</u> is
A + B same time if have velocity v
C + D same time if have no vel. rel. to object.