$$x_1 = \frac{x_1' + v t_1'}{\sqrt{\quad}}$$

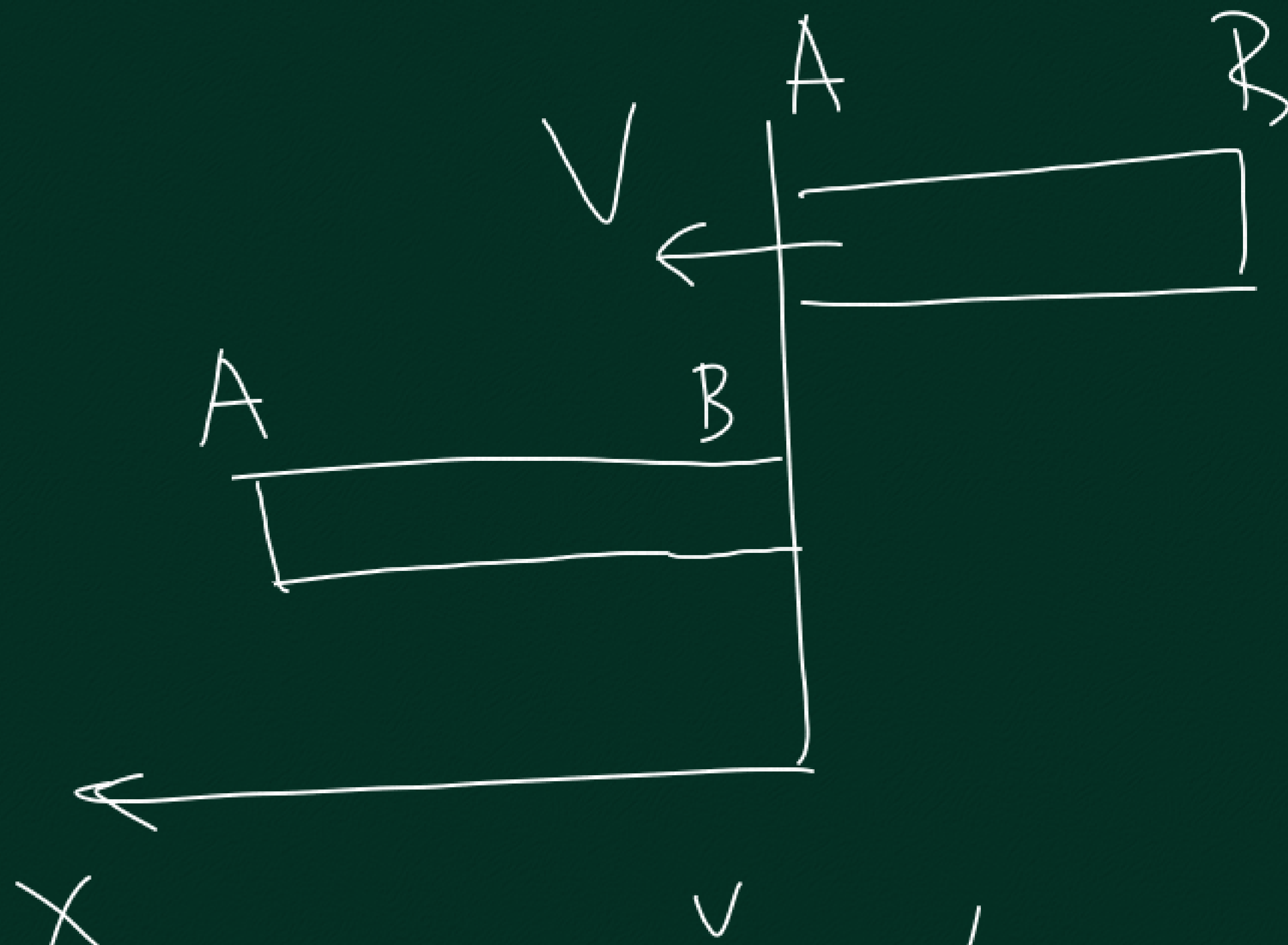
$$x_2 = \frac{x_2' + v t_2'}{\sqrt{\quad}}$$

$$t' = \frac{t - \frac{v}{c^2} x}{\sqrt{\quad}}$$

$$L = x_2 - x_1$$

x_1, x_2

$$\Delta T > \Delta T'$$



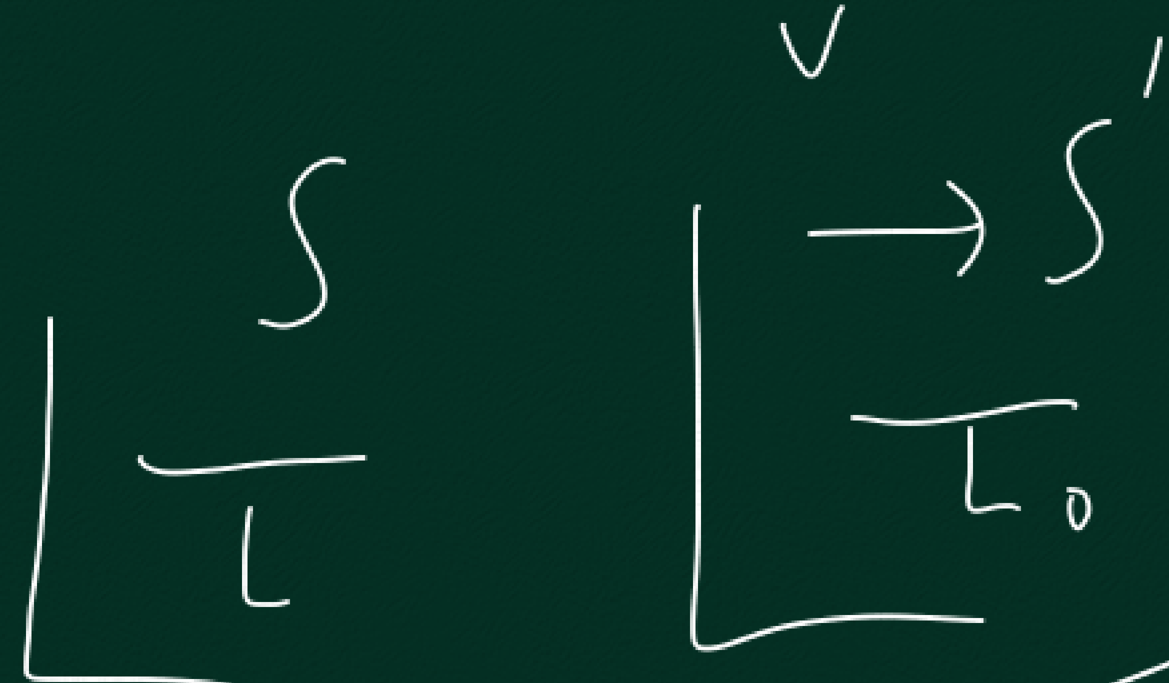
$$L = Vt \quad \text{—} \quad \boxed{S}$$

S moves right at spd v

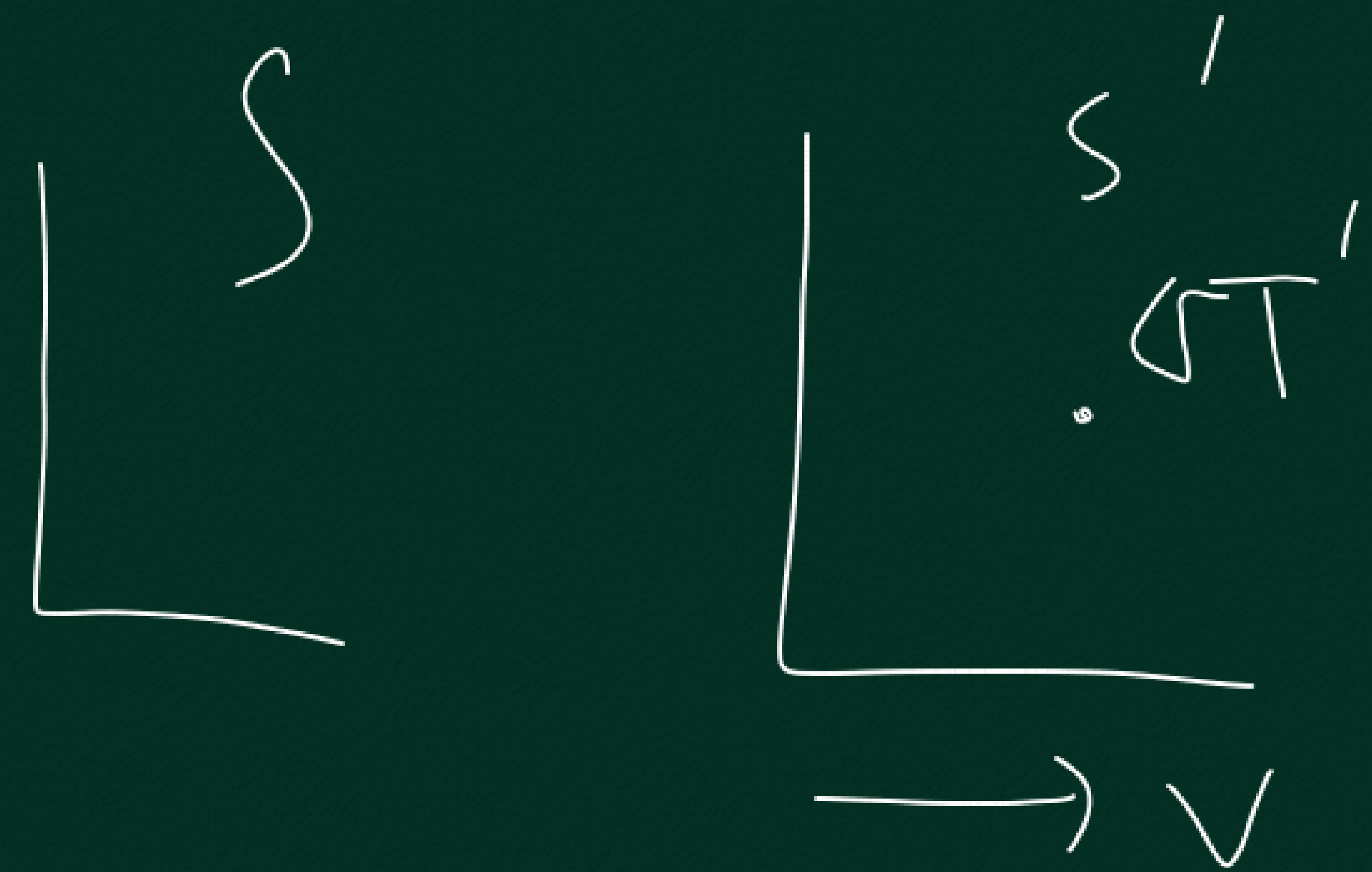
S' is the rest frame of the train

rest length $= L_0$

$L_0 > L \qquad (x, t) \qquad (x', t') \xrightarrow{} v$

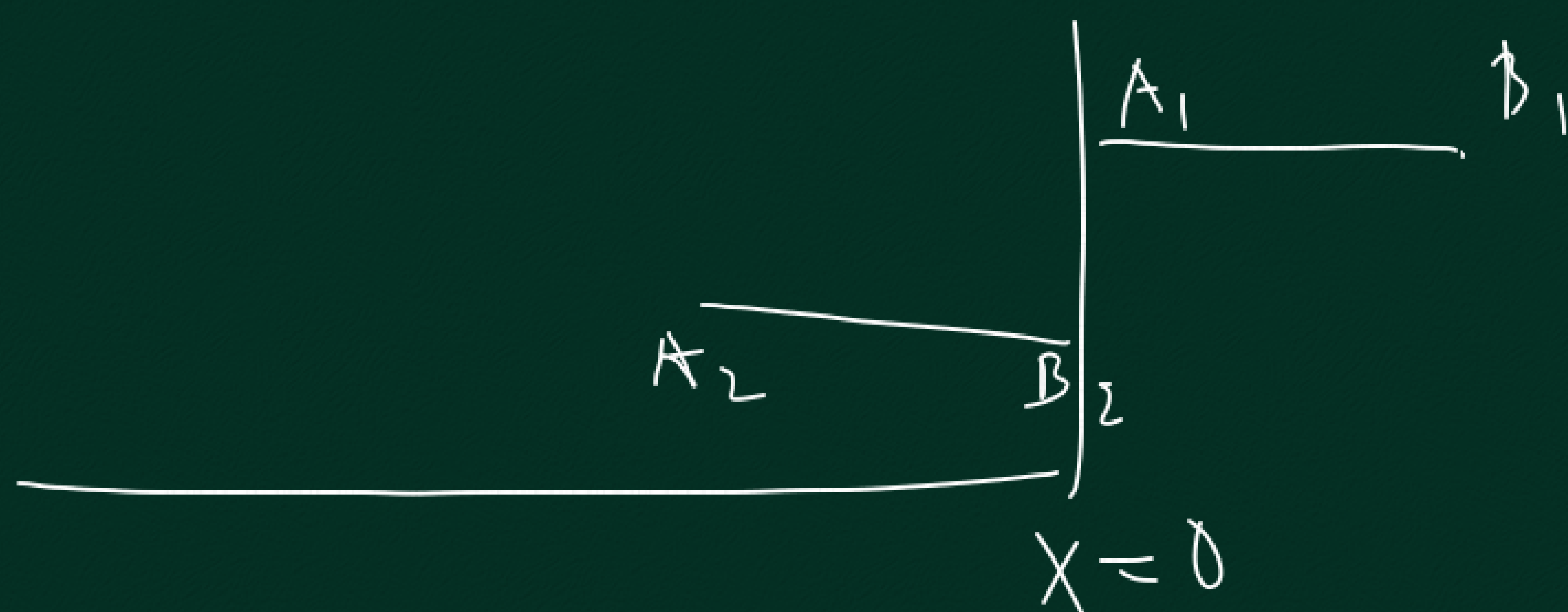


$$\boxed{L = L_0 \sqrt{1 - \frac{v^2}{c^2}}}$$



E_1 : A crosses post

E_2 : B 〃 post

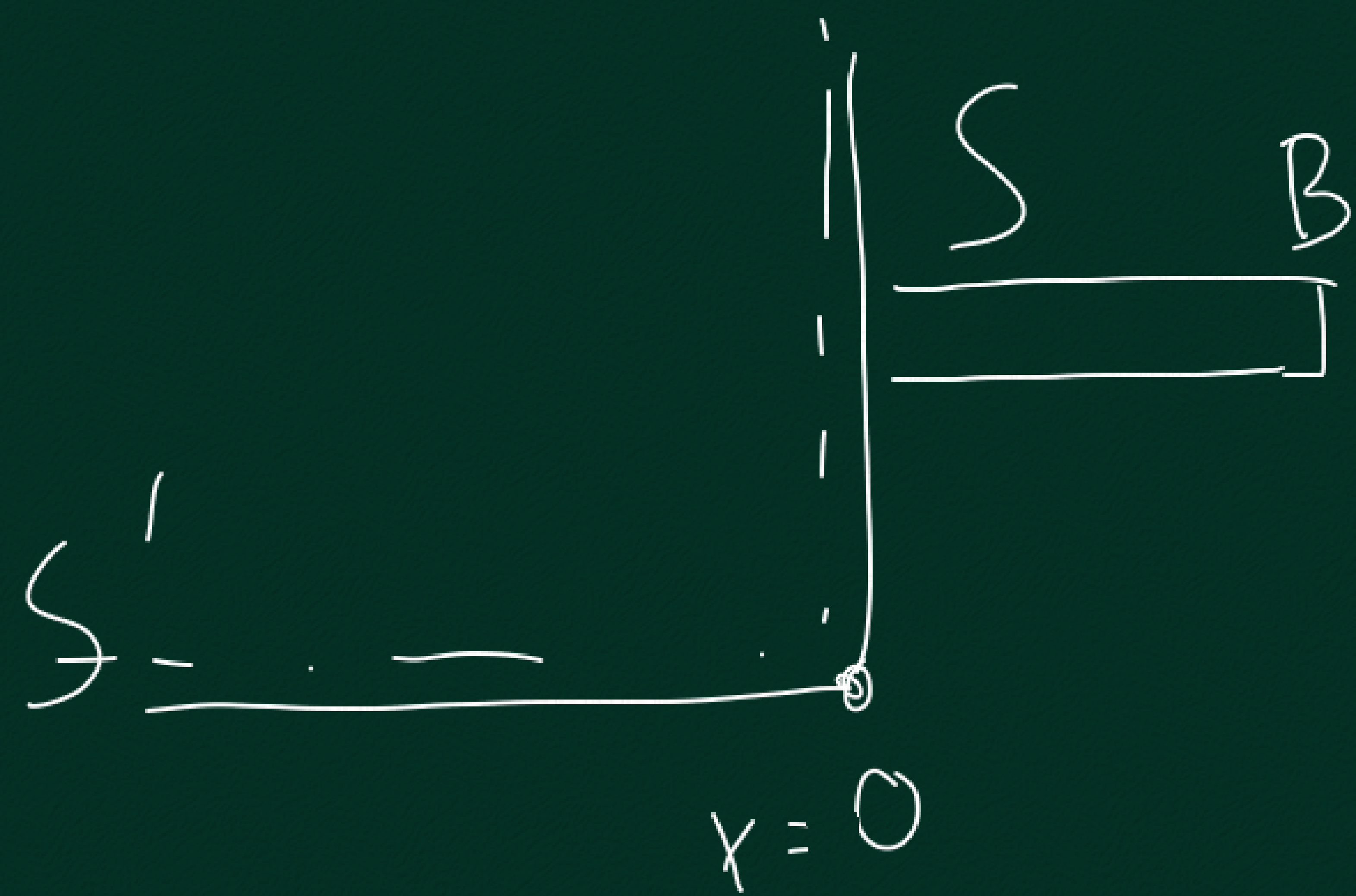


$$\Delta T' = t \Rightarrow \Delta T = \frac{t}{\sqrt{1-\beta^2}}$$

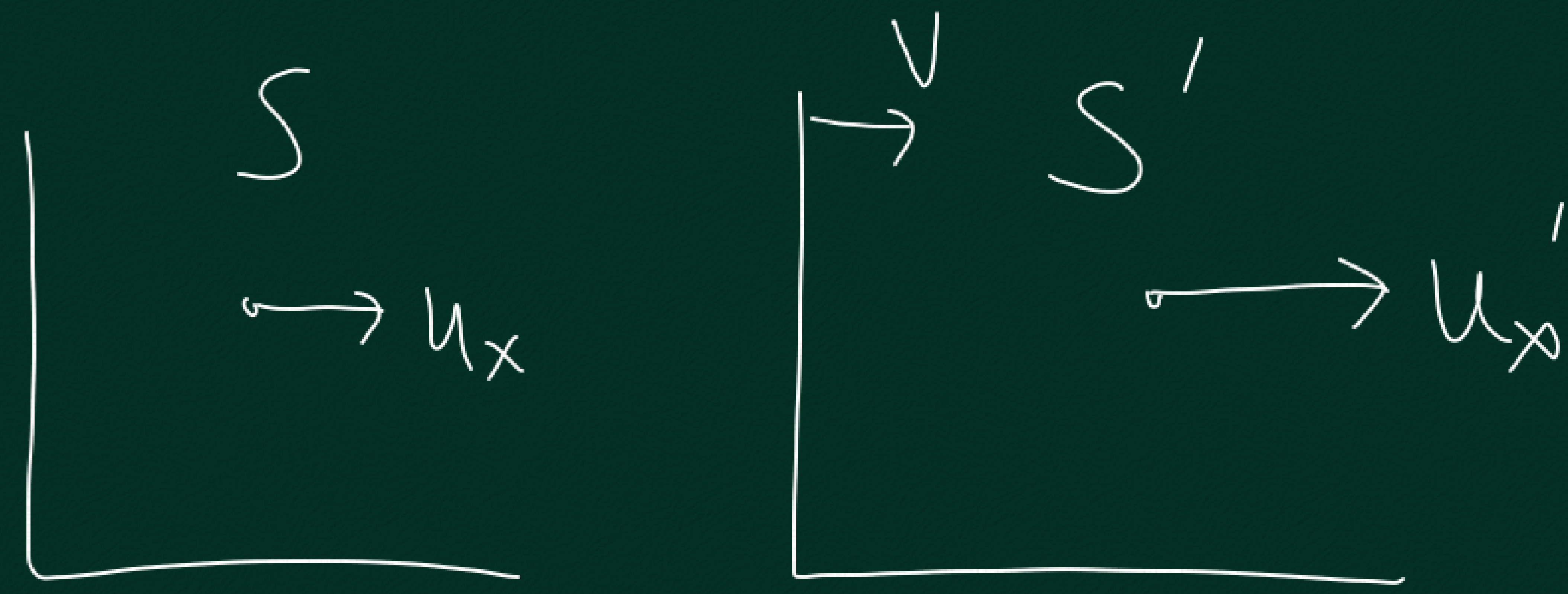
$\Delta T'$ = msrd by boy

ΔT = msrd from S'

For S both events occur at $x = 0$



E_1 $\quad (x'_A = 0,\ t'_A = 0)$



	S	S'
t_1 :	x_1 ,	x_1'
t_2 :	x_2	x_2'

① $\Delta x' = \dfrac{\Delta x - v\,\Delta t}{\sqrt{1-\beta^2}}$

$u_x = \dfrac{\Delta x}{\Delta t}$,

$u_x' = \dfrac{\Delta x'}{\Delta t'}$

② $\Delta t' = \dfrac{\Delta t - \frac{v}{c^2}\Delta x}{\sqrt{\ }}$

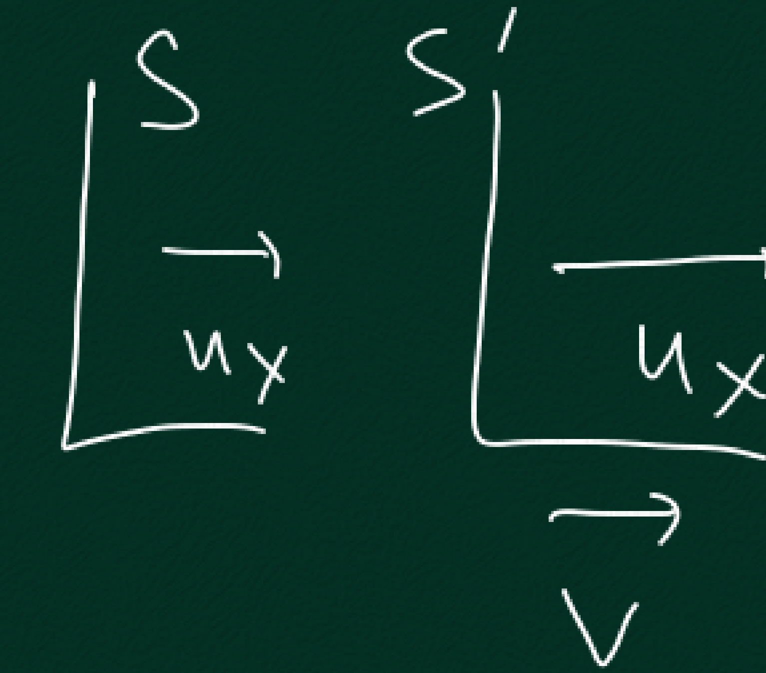
$\boxed{u_x' \leftrightarrow u_x}$

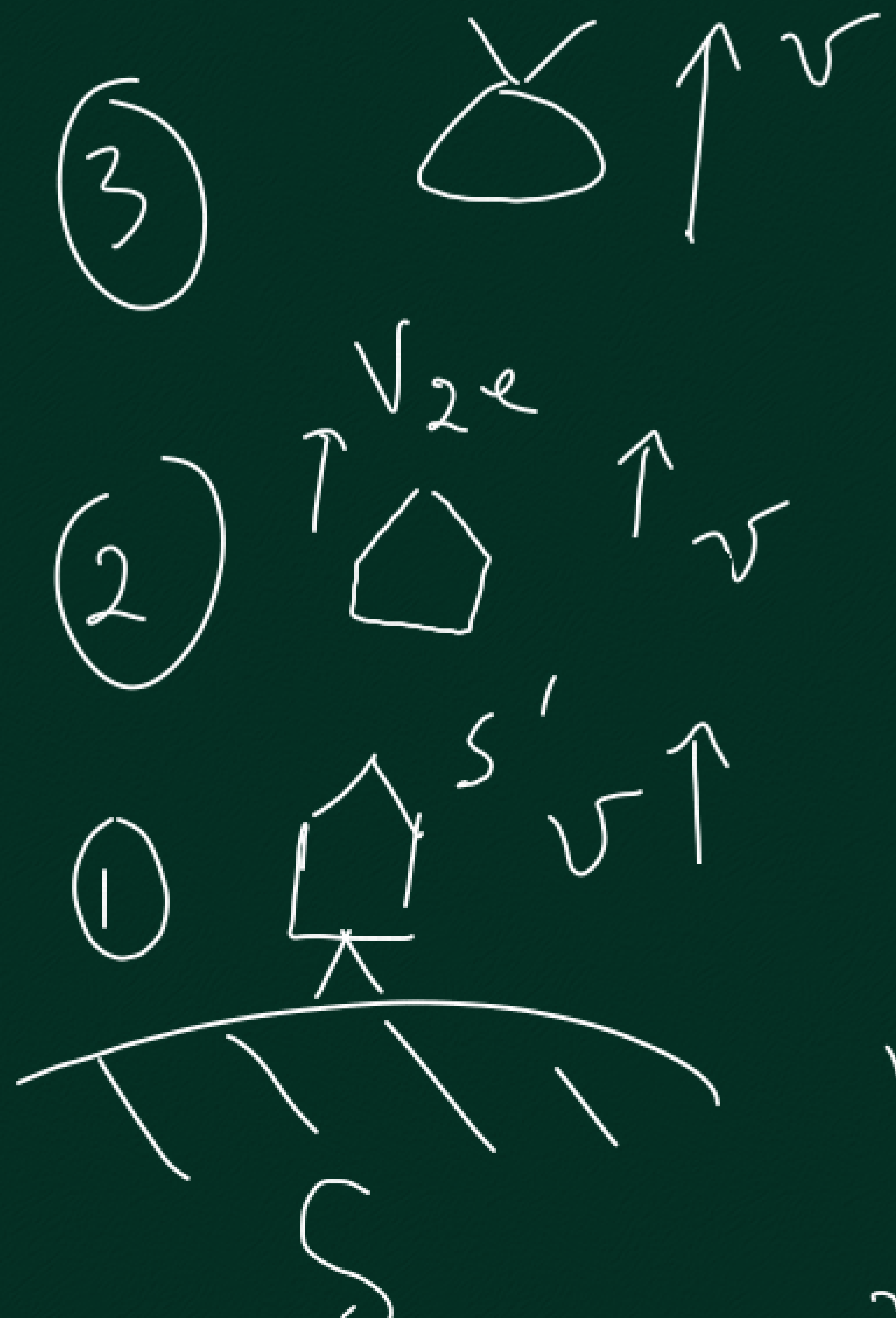
$x_1' = (x_1 - v t_1)/\sqrt{\ }$

$x_2' = (x_2 - v t_2)/\sqrt{\ }$

$x_2 - x_1 = \dfrac{\underbrace{(x_2 - x_1)}_{\Delta x} - v\underbrace{(t_2 - t_1)}_{\Delta t}}{\sqrt{\ }}$

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





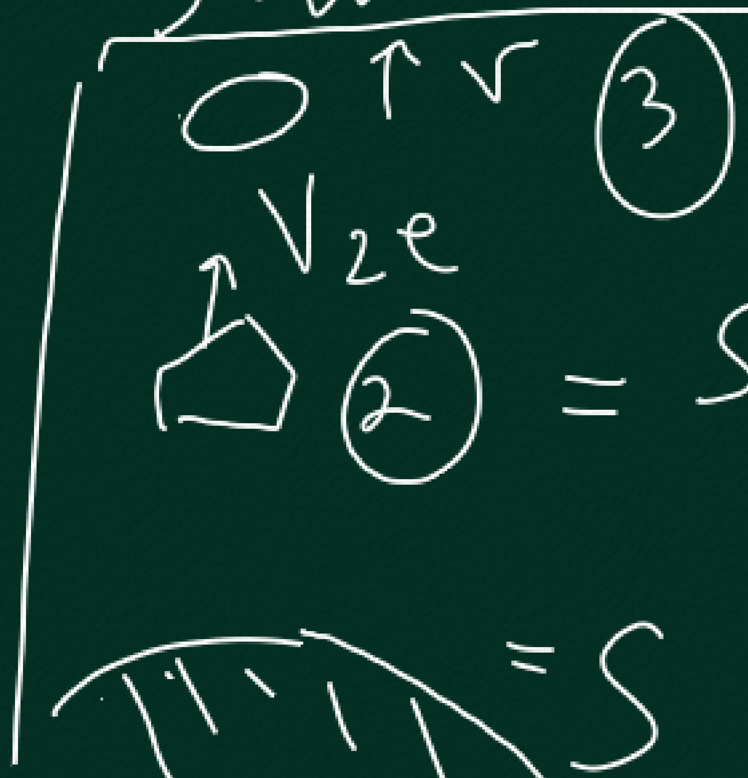
③ wrt ② probe

② wrt ① shuttle craft

① spc ship

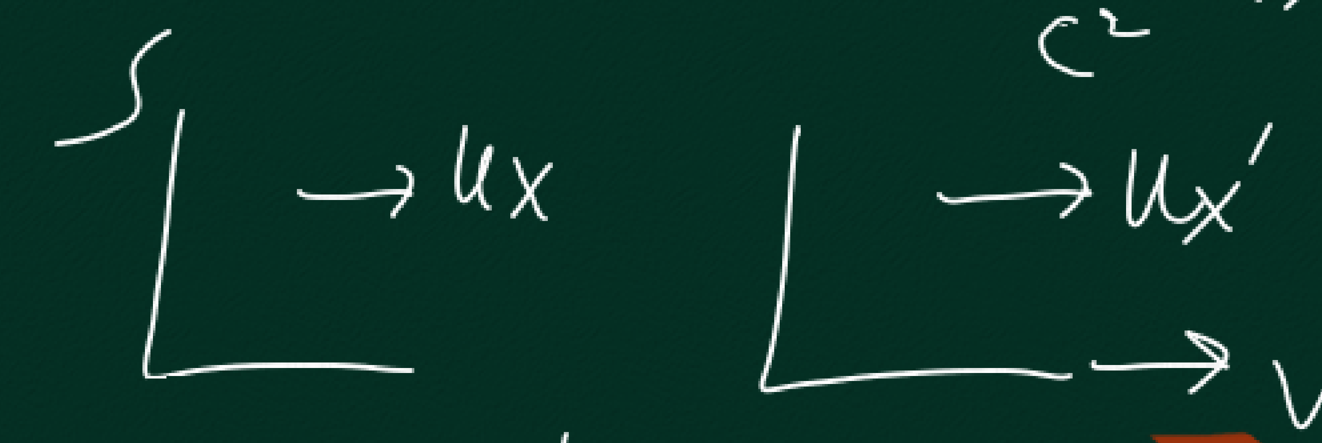
$V_{2e} = ?$

$V_{3e} = ?$



$$V_{3e} = \frac{v + V_{2e}}{1 + \frac{V_{2e}v}{c^2}} = \frac{v(3+\beta^2)}{1+3\beta^2}$$

$$u_x' = \frac{u_x - V}{1 - \frac{V}{c^2}u_x}$$



$$u_x = \frac{u_x' + V}{1 + \frac{V}{c^2}u_x'}$$

$$V_{2e} = \frac{v + v}{1 + \frac{v}{c^2}\cdot v} \approx \frac{2V}{1 + \frac{V^2}{c^2}}$$

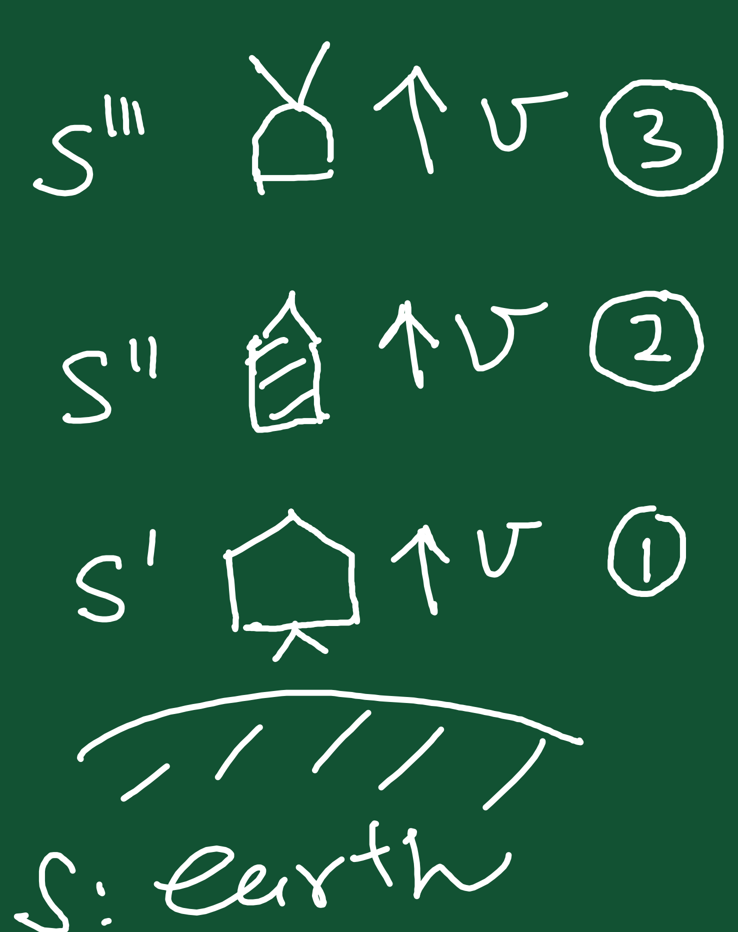
DONE CLEARLY ON NEXT PAGE

Problem on vel. transformatn.

A space-ship lifts off from earth at speed v, wrt earth. After sometime it releases a shuttle-craft upwards at speed v wrt itself (ie, space-ship). Further this shuttle-craft releases a probe upwards at speed v wrt itself (i.e., shuttle craft).

a) what is the speed of the shuttle craft v_{2e}, wrt to earth?

b) what is the speed of the probe v_{3e}, wrt earth?



Recall for S ($\rightarrow u_x$), S' ($\rightarrow V$, $\rightarrow u_x'$): $u_x' = \dfrac{u_x - V}{1 - \frac{V u_x}{c^2}}$, we use the inverse $u_x = \dfrac{u_x' + V}{1 + \frac{V}{c^2} u_x'}$

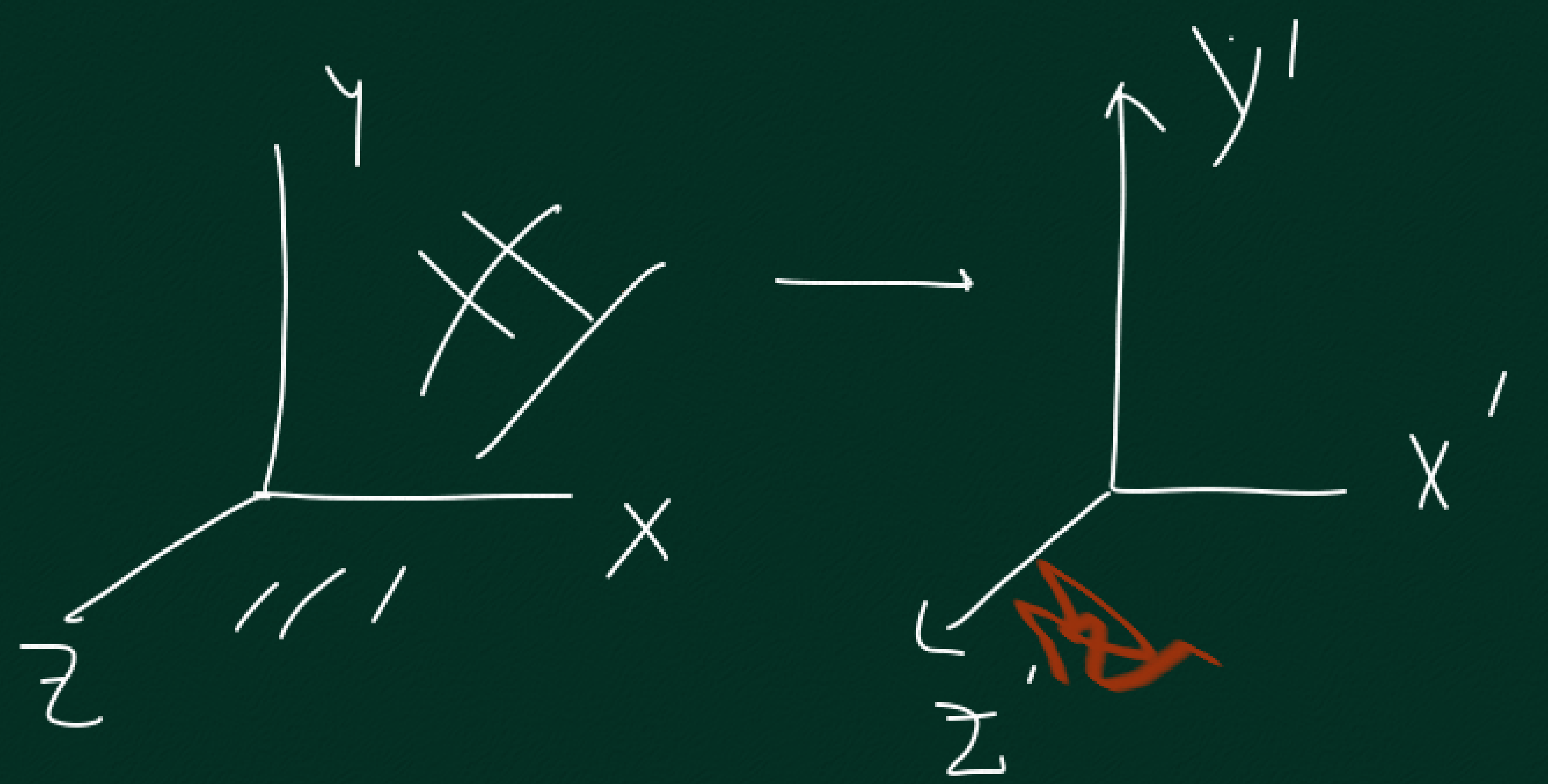
Vel of ② wrt earth $V_{2e} = \dfrac{v + v}{1 + \frac{v}{c^2} v} = 2v/(1 + v^2/c^2)$, note that ②'s speed in the moving frame of ① is $u_x' = v$

Similarly, ③'s vel in frame ② is v & frame ② moves at speed V_{2e} wrt earth

So, $v_{3e} = \dfrac{v_{2e} + v}{1 + \frac{v}{c^2} v_{2e}} \underset{\text{algebra}}{=} \dfrac{v(3 + \beta^2)}{1 + 3\beta^2}$, $\beta = v/c$

(1) All pnts on X axis shd remain on X

(2)



a_{24}

$$z' = a_{31}x + \cancel{a_{32}}y + a_{33}z + \cancel{a_{34}}t$$

$$y' = \cancel{a_{21}}x + a_{22}y + a_{23}z + \cancel{a_{24}}t$$