Problem 1.5. Interval

\[(ct')^2 - x'^2 = \left[ \frac{ct - (V/c)x}{\sqrt{1 - (V/c)^2}} \right]^2 - \left[ \frac{x - (V/c)(ct)}{\sqrt{1 - (V/c)^2}} \right]^2 \]

\[= \frac{[ct - (V/c)x]^2 - [x - (V/c)(ct)]^2}{1 - (V/c)^2} \]

\[= \frac{[(ct)^2 - 2(V/c)x(ct) + (V/c)^2x^2] - [x^2 - 2(V/c)x(ct) + (V/c)^2(ct)^2]}{1 - (V/c)^2} \]

\[= \frac{[(ct)^2 + (V/c)^2x^2] - [x^2 + (V/c)^2(ct)^2]}{1 - (V/c)^2} \]

\[= \frac{(1 - (V/c)^2)(ct)^2 - (1 - (V/c)^2)x^2}{1 - (V/c)^2} \]

\[= (ct)^2 - x^2 \]

Problem 1.9. Galactic journey
Model solution is in its own file.

Problem 1.10. Flushing out an error

At time 1:45 into the video, the Jeopardy “answer” is

\[x^1 = \frac{x - Vt}{\sqrt{1 - x^2/c^2}} \]

\[y^1 = y \]

\[t = \frac{t - Vx/c^2}{\sqrt{1 - V^2/c^2}} \]

This is a silly set of equations. The first one isn’t even dimensionally correct! (You may think that all the rules of common sense are thrown out in relativity. No! Equations still need to be dimensionally consistent.)

The last one shows \(t\) equal to an expression involving \(t\). Dumb.

Clearly, this is supposed to be the Lorentz transformation,

\[x' = \frac{x - Vt}{\sqrt{1 - (V/c)^2}} \]

\[y' = y \]

\[z' = z \]

\[t' = \frac{t - Vx/c^2}{\sqrt{1 - (V/c)^2}} \]
Problem concerning “Pole in the barn”
In the vaulter’s frame:

- The pole is stationary and the barn moves left.
- The pole is 100 feet long and the barn is 60 feet wide.
- The two events occur in the opposite sequence.
- Barn clocks tick slowly, but no clocks are shown so this doesn’t affect the sketch.

Vaulter’s frame: