Week 2 Worksheet
Special Relativity (Possibly) Review

Jacob Erlikhman

January 27, 2025

Exercise 1. Squishing a Bug. A rectangular piece of wood is cut from a board. A T-shaped cut is then made in this piece to obtain two pieces, one U-shaped and one T-shaped, see Fig. 1 below. The length of the protruding piece is D, and furthermore a bit of the hole is cut out, so that it is of depth $D + \varepsilon$, where $\varepsilon \ll D$. When the pieces are put together, a bug of a size less than ε is able to live between the two pieces. Now, the T-shaped piece is accelerated to a relativistic velocity toward the second piece. They collide. Does the bug get squashed?

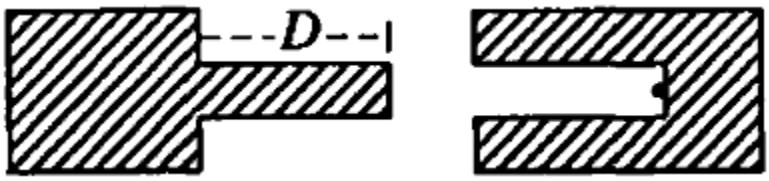

Figure 1: Two blocks and a bug in their rest frame.

Exercise 2.

a) A meterstick is moving in a straight horizontal line (parallel to the orientation of the stick). A metal plate with a 1 m diameter circular hole in it is rising vertically, perpendicular to the stick. The stick is moving so that its contracted length is 10 cm, so in our frame it easily fits through the hole and ends up on the other side of the plate. Explain what happens in the reference frame of an observer sitting on the stick. See Fig. 2a.

b) A 1 m hole is cut out of a thin table. A thin meterstick moves along the table toward the hole. Explain what happens in both reference frames. See Fig. 2b.

Exercise 3. Superball Clocks. Consider a "clock" which is made up of a ball bouncing back-and-forth between two walls in a gravity-free space. The walls are a distance D apart, and the ball moves with constant speed v_0. An identical clock in a spaceship moves past us to the right at speed V. The motion of the ball in our frame is perpendicular to the velocity of the ship **V**.

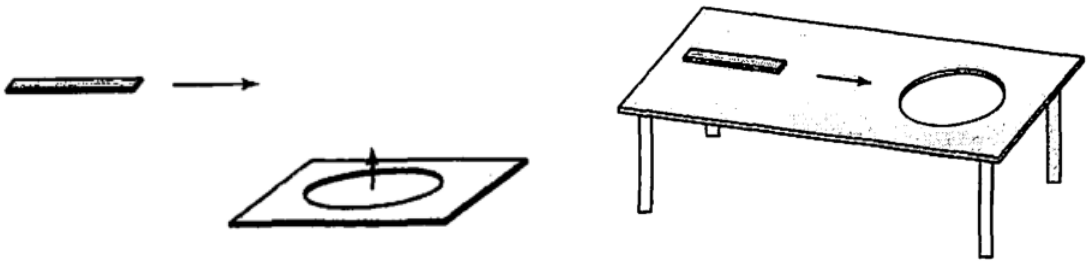

Figure 2: Exercise 2(a) left and 2(b) right.

a) Draw a picture of the clocks in i) their rest frames and ii) the frames in which they're moving, indicating the ball's trajectory in each.

b) How long does it take the ship clock to tick once?

c) Does the ship clock run slow, fast, or at the same rate as our clock, measured in our frame? Explain. Does the result agree with time-dilation formulas or not?