1.1 Read sections 1-5 of Landau and Lifshitz.

After reading these sections, for credit write “I have read sections 1-5 of Landau and Lifshitz.”

1.2 The relativity of simultaneity

Refer to Figure 1 of Landau and Lifshitz. Suppose the points B and C are a distance $d$ from A, as measured in the $K'$ frame, and suppose the $K'$ frame moves at a speed $V$ with respect to the $K$ frame.

What is the time difference between the arrival of the light signal at B and C for an observer in the $K$ frame? Give your answer in terms of $\gamma = 1/\sqrt{1 - V^2/c^2}$, $\beta = V/c$, and $\tau = d/c$.

1.3 A length contraction problem

A thin “rigid” rod of proper length 10 cm moves over a flat table. In its path is a hole of proper width 10 cm. Suppose the rod moves so fast that its Lorentz factor is $\gamma = 10$. An observer $A$ at rest relative to the table predicts that since the rod is only 1 cm long, it will fall into the 10 cm hole and hit the far side of the hole, as sketched below. However, an observer $B$ moving with the same horizontal speed as the rod predicts that since the hole is only 1 cm wide the rod will pass over the hole.

![Figure 1: Observer A’s view (not to scale).](image)

(a) Which prediction is correct? If you choose A sketch what happens in B’s frame of reference, and vice versa.

(b) At the instant when the leading face of the rod is in the same plane as the far wall, how far from the top of the hole is the bottom of the rod? Answer in units of cm.

Assume the rod does not tumble (for example, suppose the hole contains a trap door which is removed downward and with sufficient acceleration to allow the rod to fall freely at the instant the observer $A$ sees the back end of the rod leave the table). Also, assume any time delays caused by the propagation of stresses in the rod or table (or trap door) are negligible.

1.4 Interval invariance

(a) Use the Lorentz transformation equations to show that $ds^2 = c^2 dt^2 - dx^2 - dy^2 - dz^2$ is invariant under such transformations.

(b) Show that $ds^2 = c^2 dt^2 - dx^2 - dy^2 - dz^2$ is not invariant under Galilean transformations.

Assume the standard configuration of inertial frames $K$ and $K'$. 