2.1 Additive rapidities

A particle moves at speed \( u = c \tanh \xi \) relative to a coordinate system that moves at speed \( v = c \tanh \psi \) (in the same direction) relative to the lab frame. The particle moves at speed \( w = c \tanh \eta \) relative to the lab frame. Show that the rapidities are additive, i.e., \( \eta = \xi + \psi \).

2.2 Rolling carts

A cart rolls along a long table with speed \( V \). A smaller cart rolls on the first cart in the same direction with velocity \( V \) relative to the first cart. A third cart, smaller than the second, rolls on the second cart in the same direction with velocity \( V \) relative to the second cart, and so on for \( n \) carts.

(a) What is the speed \( V_n \) of the \( n^{th} \) cart relative to the table?

(b) What does \( V_n \) tend to as \( n \to \infty \)?

2.3 A “twin paradox” problem

A rocket ship leaves Earth in the year 2000. One of a pair of twins born in 1980 remains on Earth; the other rides in the rocket. The rocket ship is so constructed that it has an acceleration \( g = 9.8 \text{ m/s} \) in its own rest frame (this makes the occupants feel at home). It accelerates in a straight-line path for 5 years (by its own clocks), decelerates at the same rate for 5 more years, turns around, accelerates for 5 years, decelerates for 5 years, and lands on Earth. The twin in the rocket ship is 40 years old.

(a) What year is it on Earth?

(b) How far away from Earth did the rocket ship travel?

2.4 Read sections 6 and 83 of Landau and Lifshitz.

After reading these sections, for credit write “I have read sections 6 and 83 of Landau and Lifshitz”.