

Homework 05

Physics II

Due Friday, May 10, 2024

College of the Atlantic. Spring 2024

There are two parts to this assignment.

Part 1: WeBWorK. Do Homework 05 which you will find on your WeBWorK page. I recommend doing the WeBWorK part of the homework first. This will enable you to benefit from WeBWorK's instant, if not necessarily friendly, feedback before you do part two.

Part 2: Not WeBWorK. Below is a non-WeBWorK problem.

- If you want, you can do these problems in pairs and hand in only one write-up.
- “Hand in” the problem on google classroom. You can take a picture of your work, or type up your work, or scan your work.

1. This problem¹ is based on problem R7R.2 from Tom Moore *Six Ideas that Shaped Physics: Unit R (second edition)*, (2003). Moore's problem is adapted from a problem in B.M. Casper and R.J. Noer², *Revolutions in Physics* (1972).

Anastajia and Beowulf stand right next to a train track. They are 40 ns apart. Each has a purple glitter can of spray paint. (See Figure 1.) A train passes by with a speed of $\beta = 3/5$. Ana and Beowulf shoot a very short burst of glitter paint on the passing train at the exact same time, leaving a small, sparkly purple mark on the train. Let the release of the bursts of glitter paint be event A (for Ana) and B (for Beowulf).

- (a) Draw a reasonably accurate two-observer diagram for this situation. Include the worldlines of Ana and Beowulf and the worldlines of the spots of purple paint on the train. Take Ana and Beowulf's frame as the un-primed (at-rest) frame, and the train's frame as the moving (primed) frame.
- (b) In the train frame how are apart are the spots of purple glitter? Get an exact answer using the Lorentz contraction formula and show your answer on the two-observer diagram. (The answer should be 50 ns.)
- (c) In the train frame, how far apart are Anastajia and Beowulf? Use the Lorentz contraction formula. (The answer should be 32 ns.)
- (d) So in the train's frame two cans of paint that are 32 ns apart leave purple marks on the train that are 50 ns apart? How can this be? What is going on? Argue that this apparently paradoxical result actually isn't paradoxical and explain what is really happening in the train frame.

¹The original problem involved guns and bullet holes. I modified it to be less violent.

²Mike Casper and Rich Noer were teachers of mine at Carleton College. From Mike I took *Waves* and I think one other class. Rich taught *Intro Physics*, *Experimental Methods*, and *Advanced Classical Mechanics*? I'm not sure. Rich was also my academic advisor. The textbook, which is a physics book for non physics majors, was published when I was three years old. John Visvader had a copy of the book which he gave to me in 2019, his last year before retiring. John was a wonderful colleague; he got his PhD in Philosophy when I was minus three years old.



Figure 1: Krylon Glitter Blast, Grape Glitz.