

# Unit Seven Homework

## Physics II

Due Monday, May 25, 2020

College of the Atlantic. Spring 2020

### Instructions:

- Do these problems in pairs.
  - “Hand in” the problem on google classroom. Please don’t email me the homework; it’s a lot easier for me if you submit it on classroom.
  - In addition to these problems, there are some problems that you should do on Edfinity. There is one Edfinity assignment: Homework 07. You should “hand in” these assignments individually, but of course it’s totally fine—and in fact encouraged—to work on the Edfinity problems with others.
1. Suppose Ana is at rest and is holding a 5 ns hockey stick. Beowulf is moving with a speed of  $\beta = 0.5$  relative to Ana.
    - (a) Draw a reasonably careful two-observer diagram of this situation.
    - (b) Use your diagram to estimate the length of the hockey stick in Beowulf’s frame?
    - (c) Use the Lorentz contraction formula to determine the length of the hockey stick in Beowulf’s frame, and compare this answer to what you estimated using your diagram.
  2. This problem<sup>1</sup> 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. Noer<sup>2</sup>, *Revolutions in Physics* (1972).

Anastasia 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.)

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

<sup>2</sup>Mike 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 last year, his last year before retiring. He was a wonderful colleague; he got his PhD in Philosophy when I was minus three years old.

- (c) In the train frame, how far apart are Anastasia 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.



Figure 1: Krylon Glitter Blast, Grape Glitz.