

Homework assignment 1 for Phys 2403

Due Monday, September 8, either in my mailbox in the physics office by noon, or in class at the start of class

Note: you must show your work for all problems. For many of the problems I will assign, the answers are in the back of the textbook. You may use these to make sure that you have done the problem correctly, but this underscores the importance of showing how you arrived at your conclusions. This week, I will copy the text from the book directly for the problems which I am assigning from the book so that those of you who do not yet have books can get a good start on them. In future weeks, I will not do this.

1. Appearing in the time dilation and length-contraction formulae, γ_v is a reasonable measure of the size of the relativistic effects. Roughly speaking, at what speed would observations deviate from classical¹ expectations by 1%?
2. Anna is on a railroad flatcar moving at $0.6c$ relative to Bob. Their clocks read 0 as Anna's center of mass passes Bob's. Anna's arm is outstretched in the direction the flatcar moves, and in her hand is a flashbulb. According to the wristwatch on Anna's hand, the flashbulb goes off at 100 ns. The time of this event according to Bob differs by 27 ns. (a) Is it earlier or later than 100 ns? (b) How long is Anna's arm (i.e. from her hand to her center of mass?)
3. Bob is watching Anna fly by in her new high-speed plane, which Anna knows to be 60m in length. As a greeting, Anna turns on two lights simultaneously, one at the front and one at the tail. According to Bob, the lights come on at different times, 40 ns apart. (a) Which comes on first (b) How fast is the plane moving?
4. At rest, a light source emits 532 nm light. (a) As it moves along the line connecting it and the Earth, observers on Earth see 412 nm. What is the source's velocity (magnitude and direction)? (b) Were it to move in the opposite direction at the same speed, what wavelength would be seen? (c) Were it to circle the Earth with the same speed, what wavelength would be seen?
5. An object moves toward you at nearly the speed of light (say $0.999c$). In its own reference frame, it radiates isotropically. Sketch out the rays of light in the object's reference frame that move toward you, up along the sheet of paper, down along the sheet of paper, and directly away from you. Find, in your reference frame, what the opening angle is of the cone

¹The book uses classical here to mean Newtonian. As I mentioned in class, most physicists consider relativity to be a classical, but non-Newtonian, phenomenon.

that contains half the light. Discuss some consequences of this for objects in space moving at speeds close to the speed of light.