University of Alabama
Department of Physics and Astronomy
PH 253-002 Spring 2019

Homework 1

Instructions:

1. Answer all questions below. Show your work for full credit.
2. All problems are due by 4:45pm on Wed 23 Jan as a hard copy, or by 11:59pm on Wed 23 Jan via Blackboard
3. You may collaborate, but everyone must turn in their own work.

1. A train 0.5 km long (as measured by an observer on the train) is traveling at a speed of 44 m/s. Two lightning bolts strike the ends of the train simultaneously as determined by an observer on the ground. What is the time separation as measured by an observer on the train?

2. Pions have a half life of about $\Delta t = 1.8 \times 10^{-8}$ s (i.e., half of a population of pions would decay in that time). A pion beam leaves an accelerator at a speed of $v = 0.8c$. Compute the expected distance in the lab frame over which half the pions should travel before decay by both **both** relativistic **and** classical means.

3. A stick of length L is at rest in a system O and is oriented at an angle θ with respect to the x axis. An observer in system O' travels at velocity v with respect to the system O along the x axis. What is the apparent angle θ' that the stick makes with the x' axis according to the observer in O'? The x and x' axes are parallel.

4. Rocket A travels to the right and rocket B travels to the left, with velocities of $0.8c$ and $0.6c$, respectively, relative to earth. What is the velocity of rocket A measured from rocket B?

5. At what speed is the momentum of a particle twice as great as the result obtained from the non-relativistic expression mv? Express your answer in terms of the speed of light.

6. **(a)** Through what potential difference does an electron have to be accelerated, starting from rest, to achieve a speed of $0.980c$? **(b)** What is the kinetic energy of the electron at this speed? Express your answer in both joules and electron volts.

7. An electron is released from rest and falls under the influence of gravity. In the first centimeter, what fraction of the potential energy lost is radiated away?

8. Compute the ratio of the increase of intensity of black-body radiation at a wavelength of 641 nm for an increase of temperature from 1200 to 1500 K.