Physics 22 Problem Set 8

Harry Nelson

Due Wednesday, May 30 in class

This problem set goes hard into relativity; read Chapter 12, pp. 462-472, sections 12.1-12.3.

The instructor is Harry Nelson, the TA is Joel Varley. A web page for the course is set up at http://hep.ucsb.edu/courses/ph22.

We meet MWF 1:00-1:50pm in 1640 Broida. There are **two sections**, attendance at **both** is mandatory. Joel Varley's section will take place Friday 11:00-11:50pm in 1802 Psychology, and Harry Nelson's will take place Friday 2:00-2:50pm in 2129 Girvetz. Harry Nelson's office hours will follow section until 5:00pm on Friday, either in 2129 Girvetz (if possible) or in the PSC. Joel Varley's office hours will will take place in the Physics Study Room (1019 Broida) on Tuesday from 9:00am to 10:00am, Thursday from 9:00am to 10:00am, and Friday noon-1:00pm.

Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Derive symbolic answers, and then plug in numbers after a symbolic answer is available.

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1. A spring with constant $k = 2.5\,\mathrm{N/m}$ has a mass $m = 0.1\,\mathrm{kg}$ attached to it, and the system has a damping coefficient of $b = 0.01\,\mathrm{kg/s}$. The mass is subjected to a driving force with maximum value $0.05\,\mathrm{N}$ and variable driving frequency ω.

   (a) Compute the Q for the oscillator.

   (b) Compute the displacement of the mass when $\omega = 0$; neglect transient effects.

   (c) Make a table of the steady-state amplitude of the displacement of the mass *relative to the answer to part (b)* for the following driving frequencies: $\omega = 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.05$ $4.1, 4.15, ..., 5.85, 5.9, 5.95, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0\,\mathrm{rad/s}$. Between 4.15 and 5.85 evaluate every $0.05\,\mathrm{rad/s}$.

2. K&K 12.1

3. In a moving frame, one event occurs at $x'_1 = -150\,\mathrm{cm}$ and $t'_1 = 0\,\mathrm{ns}$, and a second even occurs at $x'_2 = 150\,\mathrm{cm}$ and $t'_2 = 0\,\mathrm{ns}$. The stationary frame shares an origin with the moving frame at $t = t' = 0$. Find the coordinates (space and time) of these two events viewed in the stationary frame when the moving frame has a velocity βc relative to the stationary frame, in the x direction of:

   (a) $\beta = \sqrt{3/4}$

   (b) $\beta = -\sqrt{3/4}$

   (c) $\beta = \sqrt{15/16}$

   (d) $\beta = -\sqrt{255/256}$.

   You can take the speed of light $c = 30\,\mathrm{cm/ns}$, and give times in nanoseconds (ns).

4. K&K 12.3
