# PH 125 Quiz Solution

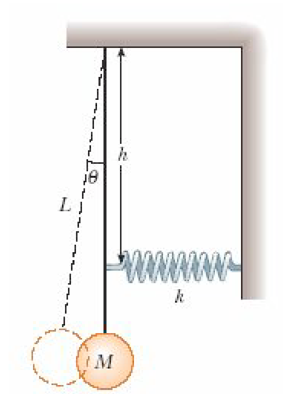
1. Two pulses move in opposite directions on a string and are identical in shape except that one has positive displacements of the elements of the string and the other has negative displacements. At the moment that the two pulses completely overlap on the string,

- ☐ the energy associated with the pulses has disappeared
- ☐ the string is not moving
- ■ the string forms a straight line
- ☐ the pulses have vanished and will not reappear.

If the pulses are identical in shape with opposite amplitudes, they will perfectly destructively interfere at the moment they overlap, giving zero amplitude.

2. A pendulum of length $L$ and mass $M$ has a spring of force constant $k$ connected to it at a distance $h$ below its point of suspension (see below). Which is the frequency of vibration $f$?

- ☐ $(2\pi L)^{-1}\sqrt{gM + kh/M}$
- ■ $(2\pi L)^{-1}\sqrt{gL + kh^2/M}$
- ☐ $(2\pi L)^{-1}\sqrt{2gL + h/kM}$
- ☐ $(2\pi L)^{-1}\sqrt{g/L + k/M}$




There is no need to solve the problem completely, there are two simpler ways. First, only the second answer has the correct units of $\mathrm{s}^{-1}$. Second, in the limit that the spring constant is zero (i.e., the spring is not present), we must recover $T = 2\pi\sqrt{g/L}$.

3. Can the amplitude $A$ and the phase constant $\varphi$ be determined for an oscillator if only the position is specified at $t = 0$?

- ☐ Yes.
- ■ No. It is necessary to know the both position and velocity at $t = 0$
- ☐ No. It is enough to know the *velocity* only, but not the position only.

Simple harmonic motion is governed by a second-order differential equation, and thus we need two parameters to uniquely determine the motion. Since the general solution is $x(t) = x_m \cos(\omega t + \varphi)$, we must have enough initial conditions to determine the amplitude $x_m$ and the phase $\varphi$. With only the position or only the velocity, we cannot determine both.

4. A block-spring system undergoes simple harmonic motion with amplitude $A$. Does the total energy change if the mass is doubled, but the amplitude is not changed? If so, by how much?

- ■ Total energy does not change.

- ▫ Total energy doubles.
- ▫ Total energy is four times greater.
- ▫ We would have to know $k$ for the spring.

The total energy of a mass-spring system is $E = \frac{1}{2}kA^2$, where $A$ is the amplitude and $k$ the spring constant. Changing the mass leaves the total energy unchanged.