PH 125 Quiz 5 Solution

1. Can the amplitude A and the phase constant φ 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.

Solution: 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 φ. With only the position or only the velocity, we cannot determine both.

2. 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.

Solution: 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, independent of the block's mass. For a given spring and a given amplitude, the energy is fixed.

3. A grandfather clock depends on the period of a pendulum to keep correct time. Suppose a grandfather clock is calibrated correctly, and then a mischievous child slides the bob of the pendulum downward on the oscillating rod. Does the grandfather clock run:

- ■ slow
- □ fast
- □ correctly?

Solution: Sliding the bob downward effectively increases the length of the pendulum, which makes its period longer. That means one second on this clock is now too long, and the clock will run behind the actual time.

4. Suppose a grandfather clock is calibrated correctly at sea level, and is then taken to the top of a very tall mountain. Does the grandfather clock run:

- ■ slow
- □ fast
- □ correctly?

Solution: The period of a pendulum goes as $\sqrt{L/g}$, where L is the length and g the gravitational constant. Going to the top of a very tall mountain, g will decrease slightly, meaning the period will increase. This, as in the last problem, makes the clock's notion of one second too long, and the clock runs slow.

5. A block on the end of a spring is pulled to a position $x = A$ and released. In one full cycle of its motion, through what total distance does it travel?

- □ $A/2$
- □ A
- □ $2A$
- ■ $4A$

Solution: Through one full cycle, the block goes from A to 0 to $-A$, and then back again through 0 to A. In total, this amounts to a round dry of $4A$.