

## Oscillations of a Mass Hanging from a Spring

Your goal today is to measure the oscillation frequency of a simple harmonic oscillator, and to compare your measurement to a predicted value based on other measurements. Of course, the idea is to see if your measured and predicted values agree to within their relative uncertainties.

Assemble the materials for this laboratory from the collection of equipment in the room, and please return them before leaving at the end of the laboratory period. Collect a spring and a mass, which comes with a hook that allows you to attach it to the spring. You'll also need a stand with clamp for the lab bench, with a holder to which you can attach the spring. Scales around the room can be used to measure the weight of the mass. (Do you think you might want to also measure the weight of the spring?) Finally, pick up a motion sensor, and hook it up through the LabPro interface, and run `LOGGERPRO`.

Your simple harmonic oscillator consists of a mass hanging from a spring. A motion sensor under the mass measures  $x(t) = A \cos(\omega t + \phi)$ . You can use this data to determine  $\omega$ . (Perhaps you will find it easier to determine the period, and from this calculate  $\omega$ .) Report your final measurement and uncertainty as  $\omega_{\text{MEAS}} \pm \delta\omega_{\text{MEAS}}$ . (I would guess that the uncertainty will be a pretty small fraction of the best value.)

By now you are all aware that you can calculate  $\omega$  from the mass  $m$  and spring constant  $k$ . In other words, if you measure  $m$  and  $k$  separately, then you should predict  $\omega$ . Scales are provided to measure  $m$ , again with a pretty small uncertainty.

Measuring  $k$  is the trickiest part, and probably will contribute your greatest uncertainty. In principle, all you need to do is hang some mass  $m$  on the spring, and measure the amount  $x$  by which the spring stretches. Combine this with  $g$ , the acceleration due to gravity, to determine  $k$ . (Derive the right formula to use. It is easy.) However, be careful that the spring is in fact "linear." That is, check several different masses and make sure that you get the same value of  $k$ , or otherwise determine an uncertainty in  $k$ . You might try plotting the extension  $x$  as a function of  $m$  and see if you get a straight line.

In any case, in the end, you will report  $\omega_{\text{PRED}} \pm \delta\omega_{\text{PRED}}$  and compare this to your measured value.