42.5: Mass on a Spring

The discussion so far has applied to simple harmonic motion in general; there are many specific examples of physical systems that act as simple harmonic oscillators. The most commonly cited example is a mass m on a spring with spring constant k. The spring constant k is a measure of how stiff the spring is, and is measured in units of newtons per meter $(\mathrm{N/m})$. Specifically, k describes how much force the spring exerts per unit distance it is extended or compressed.

A mass on a spring oscillates with angular frequency

$$\omega=\sqrt{\frac{k}{m}} \tag{42.5.1}$$

and therefore has period $T=2\pi/\omega$, or

$$T=2\pi\sqrt{\frac{m}{k}} \tag{42.5.2}$$

It really doesn't matter whether a mass on a spring moves horizontally on a frictionless surface, or bobs up and down vertically. The motion is the same-the only difference is that if you take a horizontal spring and hang it vertically, the equilibrium position will change because of gravity. The period and frequency of motion will be the same.

The importance of the spring example is not that there are government laboratories filled with researchers studying springs; rather the spring example serves as an important model and approximation for other problems. Often even a complicated force can be approximated as a linear force (Eq. 42.1.1) over some limited range. In this case one may approximately model the force as a spring force with an "effective spring constant" k, and allow at least an approximate answer to what might otherwise be a difficult problem.

There are several other examples of systems that form simple harmonic oscillators: the torsional pendulum, the simple plane pendulum, a ball rolling back and forth inside a bowl, etc.