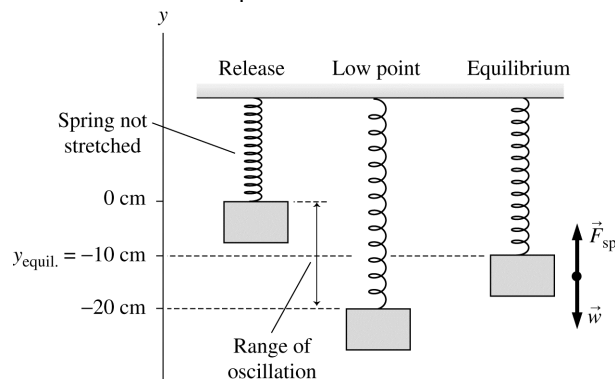


14.50. Model: The mass is in simple harmonic motion.

Visualize:



The high point of the oscillation is *at* the point of release. This conclusion is based on energy conservation. Gravitational potential energy is converted to the spring's elastic potential energy as the mass falls and stretches the spring, then the elastic potential energy is converted 100% back into gravitational potential energy as the mass rises, bringing the mass back to *exactly* its starting height. The total displacement of the oscillation – high point to low point – is 20 cm. Because the oscillations are symmetrical about the equilibrium point, we can deduce that the *equilibrium* point of the spring is 10 cm below the point where the mass is released. The mass oscillates about this equilibrium point with an amplitude of 10 cm, that is, the mass oscillates between 10 cm above and 10 cm below the equilibrium point.

Solve: The equilibrium point is the point where the mass would hang *at rest*, with $F_{sp} = w = mg$. At the equilibrium point, the spring is stretched by $\Delta y = 10 \text{ cm} = 0.1 \text{ m}$. Hooke's law is $F_{sp} = k\Delta y$, so the equilibrium condition is

$$[F_{sp} = k\Delta y] = [w = mg] \Rightarrow \frac{k}{m} = \frac{g}{\Delta y} = \frac{9.8 \text{ m/s}^2}{0.1 \text{ m}} = 98 \text{ s}^{-2}$$

The *ratio* k/m is all we need to find the oscillation frequency:

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{98 \text{ s}^{-2}} = 1.58 \text{ Hz}$$