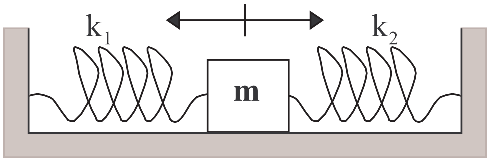
Chapter 13 Problem 56 †



Solution
Show that the angular frequency is

$$\omega = \sqrt{\frac{k_1 + k_2}{m}}$$

From Newton's 2nd law

$$\sum \vec{F} = m\vec{a}$$

There are two springs attached to this block. At equilibrium spring 1 and spring 2 are exerting equal and opposite forces. If the block is displaced to the right a distance x from equilibrium, spring 1 will be stretched and will, therefore, exert an additional force of k_1x to the left due to Hooke's law. With this same displacement spring 2 will be compressed and will exert an additional force of k_2x to the left. Therefore, Newton's 2nd law for this example is

$$\sum F_x = -k_1x - k_2x = ma$$

Acceleration is the second derivative of position giving

$$-(k_1 + k_2)x = m\frac{d^2x}{dt^2}$$

The rest of the development for the simple harmonic oscillator given in section 13-2 can be followed where the spring constant k is replaced with $(k_1 + k_2)$. This will result in an angular frequency of

$$\omega = \sqrt{\frac{k_1 + k_2}{m}}$$

†Problem from Essential University Physics, Wolfson