PS-4.1 In Fig. 4-1, two identical springs of spring constant $k$ are attached to a block of mass $m$ and to fixed supports. Show that the block's frequency of oscillation on the frictionless surface is

$$f = \frac{1}{2\pi} \sqrt{\frac{2k}{m}}$$

PS-4.2 Suppose that the two springs in Fig. 4-1 have different spring constants $k_1$ and $k_2$. Show that the frequency $f$ of oscillation of the block is then given by

$$f = \sqrt{f_1^2 + f_2^2},$$

where $f_1$ and $f_2$ are the frequencies at which the block would oscillate if connected only to spring 1 or only to spring 2.

PS-4.3 In Fig. 4-2, two springs are joined and connected to a block of mass $m$. The surface is frictionless. If the springs both have spring constant $k$, show that

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{2m}}$$

gives the block's frequency of oscillation.

PS-4.4 In Fig. 4-3, a block weighing 14.0 kg, which slides without friction on a 40° incline, is connected to the top of the incline by a massless spring of unstretched length 0.450 m and spring constant 120 N/m. (a) How far from the top of the incline does the block stop? (b) If the block is pulled slightly down the incline and released, what is the period of the resulting oscillations?

PS-4.5 A uniform spring with unstretched length $L$ and spring constant $k$ is cut into two pieces of unstretched lengths $L_1$ and $L_2$, with $L_1 = nL_2$. What are the corresponding spring constants (a) $k_1$, and (b) $k_2$ in terms of $n$ and $k$? If a block is attached to the original spring, as in Fig. 4-4, it oscillates with frequency $f$. If the spring is replaced with the piece $L_1$ or $L_2$, the corresponding frequency is $f_1$ or $f_2$. Find (c) $f_1$ and (d) $f_2$ in terms of $f$.

PS-4.6 For the system shown in Fig. 4-4, the block has a mass of 1.50 kg and the spring constant is 8.00 N/m. The damping force is given by $-b(dx/dt)$, where $b = 230$ g/s. Suppose that the block is initially pulled down a distance 12.0 cm and released. (a) Calculate the time required for the amplitude of the resulting oscillations to fall to one-third of its initial value. (b) How many oscillations are made by the block in this time?