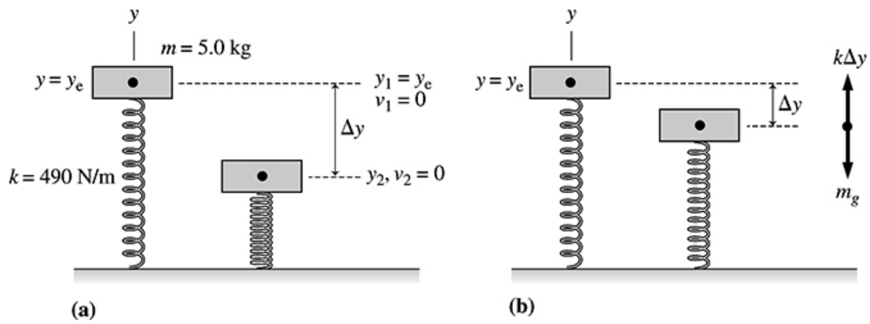
10.45. Model: Assume an ideal spring that obeys Hooke's law. There is no friction and hence the mechanical energy $K + U_s + U_g$ is conserved.

Visualize:



Solve: **(a)** When releasing the block suddenly, $K_2 + U_{s2} + U_{g2} = K_1 + U_{s1} + U_{g1}$

$$\frac{1}{2}mv_2^2 + \frac{1}{2}k(y_2 - y_e)^2 + mgy_2 = \frac{1}{2}mv_1^2 + \frac{1}{2}k(y_1 - y_e)^2 + mgy_1$$

Using $v_2 = 0$ m/s, $v_1 = 0$ m/s, and $y_1 = y_e$, we get

$$0 \text{ J} + \frac{1}{2}(490 \text{ N/m})(y_2 - y_1)^2 + mgy_2 = 0 \text{ J} + 0 \text{ J} + mgy_1 \Rightarrow (245 \text{ N/m})(y_2 - y_1)^2 = mg(y_1 - y_2)$$

$$\Rightarrow (245 \text{ N/m})(y_1 - y_2)^2 = (5.0 \text{ kg})(9.8 \text{ m/s}^2)(y_1 - y_2) \Rightarrow (y_1 - y_2) = 0.20 \text{ m}$$

(b) When lowering the block gently until it rests on the spring, the block reaches a point of static equilibrium.

$$F_{\text{net}} = k\Delta y - mg = 0 \Rightarrow \Delta y = \frac{mg}{k} = \frac{(5.0 \text{ kg})(9.8 \text{ m/s}^2)}{490 \text{ N/m}} = 0.10 \text{ m}$$

(c) In part (b), at a point 0.10 m down, the forces balance. But in part (a) the block has kinetic energy as it reaches 0.10 m. So the block continues on past the equilibrium point until all the gravitational potential energy is stored in the spring.