68. (a) The effect of a (sliding) friction is described in terms of energy dissipated as shown in Eq. 8-29. We have

$$\Delta E = K + \frac{1}{2}k(0.08)^2 - \frac{1}{2}k(0.10)^2 = -f_k(0.02)$$

where distances are in meters and energies are in Joules. With $k = 4000$ N/m and $f_k = 80$ N, we obtain $K = 5.6$ J.

(b) In this case, we have $d = 0.10$ m. Thus,

$$\Delta E = K + 0 - \frac{1}{2}k(0.10)^2 = -f_k(0.10)$$

which leads to $K = 12$ J.

(c) We can approach this two ways. One way is to examine the dependence of energy on the variable d:

$$\Delta E = K + \frac{1}{2}k\,(d_0 - d)^2 - \frac{1}{2}kd_0^2 = -f_k d$$

where $d_0 = 0.10$ m, and solving for K as a function of d:

$$K = -\frac{1}{2}kd^2 + (kd_0)\,d - f_k d\ .$$

In this first approach, we could work through the $\frac{dK}{dd} = 0$ condition (or with the special capabilities of a graphing calculator) to obtain the answer $K_{\text{max}} = \frac{1}{2k}(kd_0 - f_k)^2$. In the second (and perhaps easier) approach, we note that K is maximum where v is maximum – which is where $a = 0 \implies$ equilibrium of forces. Thus, the second approach simply solves for the equilibrium position

$$|F_{\text{spring}}| = f_k \quad\Longrightarrow\quad kx = 80\ \ .$$

Thus, with $k = 4000$ N/m we obtain $x = 0.02$ m. But $x = d_0 - d$ so this corresponds to $d = 0.08$ m. Then the methods of part (a) lead to the answer $K_{\text{max}} = 12.8 \approx 13$ J.