8.39.

\textbf{c) Use the CWE theorem.}

\[ W_{\text{nonconservative}} = \Delta(KE + PE) = \Delta KE + \Delta PE = 1.20 \times 10^4 \text{ J} + (-2.94 \times 10^4 \text{ J}) = -1.74 \times 10^4 \text{ J}. \]

\textbf{8.39}

\textbf{a) The mechanical energy} \( E \) \textbf{is sum of the kinetic and potential energies; hence}

\[ E_i = KE_i + PE_i. \]

Choose the zero of gravitational potential energy to be at the same height as the horizontal surface. The potential energy is then just the potential energy associated with the force of the spring.

\[ E_i = \frac{1}{2} mv_i^2 + \frac{1}{2} kx_i^2. \]

The initial speed \( v_i \) is zero, so

\[ E_i = \frac{1}{2} kx_i^2 = \frac{1}{2}(4.00 \times 10^3 \text{ N/m})(1.50 \text{ m})^2 = 4.50 \times 10^3 \text{ J}. \]

\textbf{b) During each passage over the rough ground, the force of kinetic friction is a constant force, so its work can be calculated from}

\[ W_{\text{friction}} = f_k \cdot \Delta \vec{r}. \]

The kinetic force of friction and the change in the position vector of the system point in opposite directions; hence the angle between the vectors is \( 180^\circ \) and the work is

\[ W_{\text{friction}} = f_k \Delta r \cos 180^\circ = -f_k \Delta r = -\mu_k N \Delta r. \]

Since the surface is horizontal, the magnitude of the normal force of the surface is equal to the magnitude of the weight (which follows from applying Newton’s second law to the vertical direction and realizing the vertical acceleration is zero). Therefore,

\[ W_{\text{friction}} = -\mu_k mg \Delta r = -0.200(60.0 \text{ kg})(9.81 \text{ m/s}^2)(2.00 \text{ m}) = -235 \text{ J}. \]

\textbf{c) According to part b), when the system passes over the rough ground, the total mechanical energy decreases by 235 J. Hence, as the system approaches the second spring for the first time, its total mechanical energy is}

\[ 4.50 \times 10^3 \text{ J} - 235 \text{ J} = 4.27 \times 10^3 \text{ J}. \]

After the spring is compressed to its maximum extent, the system is (momentarily) at rest with zero kinetic energy and thus its mechanical energy is equal to the potential energy associated with the second spring.

\[ 4.27 \times 10^3 \text{ J} = \frac{1}{2} kx^2 \]

Where \( k = 3.00 \times 10^3 \text{ N/m} \) is the second spring constant, and \( x \) is the amount by which it is compressed. Hence,

\[ x = \pm \sqrt{\frac{2(4.27 \times 10^3 \text{ J})}{k}} = \pm \sqrt{\frac{2(4.27 \times 10^3 \text{ J})}{3.00 \times 10^3 \text{ N/m}}} = -1.69 \text{ m}. \]

We choose the negative root since the spring is compressed.

\textbf{d) The system has an initial mechanical energy of 4.50 \times 10^3 \text{ J}, and loses mechanical energy only when it crosses the rough ground. Each time it crosses the rough ground, it loses 235 J. It therefore takes}

\[ \frac{4.50 \times 10^3 \text{ J}}{235 \text{ J}} = 19.1 \text{ crossings to lose all its mechanical energy and come to rest. Hence it makes 19 complete traversals of the rough ground.} \]