Solving problems:

Chapter 3: Work and Mechanical Energy

Homework: 22, 56, 79
24. A block of mass \( m = 2.0 \text{ kg} \) is dropped from height \( h = 50 \text{ cm} \) onto a spring of spring constant \( k = 1960 \text{ N/m} \). Find the maximum distance the spring is compressed.

**Gravitational potential energy:**

\[
U_g = mgh
\]

**Elastic potential energy:**

\[
U_e = \frac{1}{2}kx^2
\]

**Kinetic energy:**

\[
K = \frac{1}{2}mv^2
\]

**Conservation of mechanical energy:**

\[
K_i + U_i = K_f + U_f
\]

\[
mg(h + x) = \frac{1}{2}kx^2 \Rightarrow x = \frac{mg \pm \sqrt{(mg)^2 + 2mghk}}{k}
\]

We select \( x > 0 \), so:

\[
x = 0.11(\text{m})
\]
56. You push a 2.0 kg block against a horizontal spring, compressing the spring by 12 cm. Then you release the block, and the spring sends it sliding across a tabletop. It stops 75 cm from where you released it. The spring constant is 170 N/m. What is the block-table coefficient of kinetic friction?

At the beginning:

\[ U_e = \frac{1}{2} kx^2 \]

When the block stops, elastic potential energy is completely transferred to thermal energy (work done by friction):

\[ U_e = \frac{1}{2} kx^2 = \Delta E_{\text{thermal}} = f_k d \]

\( f_k \) is the kinetic frictional force:\[ f_k = \mu_k mg \]

\[ \Rightarrow \mu_k = \frac{kx^2}{2mgd} = \frac{170 \times 0.12^2}{2 \times 2.0 \times 9.8 \times 0.75} = 0.083 \]
79. 1500 kg car begins sliding down a 5.0 inclined road with a speed of 30 km/h. The engine is turned off, and the only forces acting on the car are a net frictional force from the road and the gravitational force. After the car has traveled 50 m along the road, its speed is 40 km/h. (a) How much is the mechanical energy of the car reduced because of the net frictional force? (b) What is the magnitude of that net frictional force?

\( \Delta E_{\text{mec}} = \Delta K + \Delta U = K_f - K_i + U_f - U_i \)

\[ = mg \times 50 \times \sin 50^0 + \frac{1}{2}m (v_f^2 - v_i^2) \]

b) \( W = \Delta E_{\text{mec}} + \Delta E_{\text{thermal}} \)

No external force: \( W=0 \)

\( W = 0 \iff \Delta E_{\text{thermal}} = -\Delta E_{\text{mec}} \)

\[ f_k d = -\Delta E_{\text{mec}} \iff f_k = -\Delta E_{\text{mec}} / d \]