6.2: a) “Pulling slowly” can be taken to mean that the bucket rises at constant speed, so the tension in the rope may be taken to be the bucket’s weight. In pulling a given length of rope, from Eq. (6.1),
\[ W = Fs = mgs = (6.75 \text{ kg}) (9.80 \text{ m/s}^2) (4.00 \text{ m}) = 264.6 \text{ J.} \]
b) Gravity is directed opposite to the direction of the bucket’s motion, so Eq. (6.2) gives the negative of the result of part (a), or \(-265 \text{ J.}\) c) The net work done on the bucket is zero.

6.3: \((25.0 \text{ N})(12.0 \text{ m}) = 300 \text{ J.}\)

6.16: Doubling the speed increases the kinetic energy, and hence the magnitude of the work done by friction, by a factor of four. With the stopping force given as being independent of speed, the distance must also increase by a factor of four.

6.22: a) If there is no work done by friction, the final kinetic energy is the work done by the applied force, and solving for the speed,
\[ v = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2Fs}{m}} = \sqrt{\frac{2(36.0 \text{ N})(1.20 \text{ m})}{(4.30 \text{ kg})}} = 4.48 \text{ m/s.} \]
b) The net work is \(Fs - F_k s = (F - \mu_k mg)s\), so
\[ v = \sqrt{\frac{2(F - \mu_k mg)s}{m}} \]
\[ = \sqrt{\frac{2(36.0 \text{ N} - (0.30)(4.30 \text{ kg})(9.80 \text{ m/s}^2))(1.20 \text{ m})}{(4.30 \text{ kg})}} \]
\[ = 3.61 \text{ m/s.} \]
(Note that even though the coefficient of friction is known to only two places, the difference of the forces is still known to three places.)

6.42: The initial and final kinetic energies of the brick are both zero, so the net work done on the brick by the spring and gravity is zero, so \((1/2)kd^2 - mgh = 0\), or
\[ d = \sqrt{\frac{2mgh}{k}} = \sqrt{\frac{2(1.80 \text{ kg})(9.80 \text{ m/s}^2)(3.6 \text{ m})}{(450 \text{ N/m})}} = 0.53 \text{ m.} \] The spring will provide an upward force while the spring and the brick are in contact. When this force goes to zero, the spring is at its uncompressed length.

6.44: Set time to stop:
\[ \Sigma F = ma : \mu_k mg = ma \]
\[ a = \mu_k g = (0.200)(9.80 \text{ m/s}^2) = 1.96 \text{ m/s}^2 \]
\[ v = v_0 + at \]
\[ 0 = 8.00 \text{ m/s} - (1.96 \text{ m/s}^2)t \]
\[ t = 4.08 \text{ s} \]
\[
P = \frac{KE}{t} = \frac{\frac{1}{2}mv^2}{t} = \frac{\frac{1}{2}(20.0 \text{ kg})(8.00 \text{ m/s}^2)}{4.08 \text{ s}} = 157 \text{ W}
\]

**6.48:** a) The number per minute would be the average power divided by the work \((mgh)\) required to lift one box,

\[
\frac{(0.50 \text{ hp})(746 \text{ W/hp})}{(30 \text{ kg})(9.80 \text{ m/s}^2)(0.90 \text{ m})} = 1.41 /s,
\]
or 84.6 /min.  

b) Similarly,

\[
\frac{(100 \text{ W})}{(30 \text{ kg})(9.80 \text{ m/s}^2)(0.90 \text{ m})} = 0.378 /s,
\]
or 22.7 /min.

**6.66:** Let \(x\) be the distance past P.

\[
\mu_k = 0.100 + Ax
\]

when \(x = 12.5 \text{ m}\), \(\mu_k = 0.600\)

\[
A = 0.500/12.5 \text{ m} = 0.0400/\text{m}
\]

(a)

\[
W = \Delta KE : W_i = KE_i - KE_i
\]

\[
= - \int \mu_kmgdx = 0 - \frac{1}{2}mv_i^2
\]

\[
g \int_{0}^{x_i} (0.100 + Ax)dx = \frac{1}{2}v_i^2
\]

\[
g \left[ (0.100)x_i + A \frac{x_i^2}{2} \right] = \frac{1}{2}v_i^2
\]

\[
(9.80 \text{ m/s}^2) \left[ (0.100)x_i + (0.0400/\text{m}) \frac{x_i^2}{2} \right] = \frac{1}{2}(4.50 \text{ m/s})^2
\]

Solve for \(x_i : x_i = 5.11 \text{ m}\)

(b) \(\mu_k = 0.100 + (0.0400/\text{m})(5.11 \text{ m}) = 0.304\)

(c) \(W_i = KE_i - KE_i\)

\[
- \mu_kmgx = 0 - \frac{1}{2}mv_i^2
\]

\[
x = v_i^2 / 2\mu_k g = \frac{(4.50 \text{ m/s})^2}{2(0.100)(9.80 \text{ m/s}^2)} = 10.3 \text{ m}
\]
6.70: a) This is similar to Problem 6.64, but here \( \alpha > 0 \) (the force is repulsive), and \( x_2 < x_1 \), so the work done is again negative;

\[
W = \alpha \left( \frac{1}{x_1} - \frac{1}{x_2} \right) = \left( 2.12 \times 10^{-26} \text{ N} \cdot \text{m}^2 \left( (0.200 \text{ m}^{-1}) - (1.25 \times 10^9 \text{ m}^{-1}) \right) \right) = -2.65 \times 10^{-17} \text{ J}.
\]

Note that \( x_1 \) is so large compared to \( x_2 \) that the term \( \frac{1}{x_1} \) is negligible. Then, using Eq. (6.13)) and solving for \( v_2 \),

\[
v_2 = \sqrt{\frac{v_1^2 + \frac{2W}{m}}{m}} = \sqrt{\frac{(3.00 \times 10^5 \text{ m/s})^2 + \frac{2(-2.65 \times 10^{-17} \text{ J})}{(1.67 \times 10^{-27} \text{ kg})}} = 2.41 \times 10^3 \text{ m/s}.
\]

b) With \( K_2 = 0, W = -K_1 \). Using \( W = -\frac{\alpha}{x_2} \),

\[
x_2 = \frac{\alpha}{K_1} = \frac{2\alpha}{mv_1^2} = \frac{2(2.12 \times 10^{-26} \text{ N} \cdot \text{m}^2)}{(1.67 \times 10^{-27} \text{ kg})(3.00 \times 10^5 \text{ m/s})^2} = 2.82 \times 10^{-10} \text{ m}.
\]

c) The repulsive force has done no net work, so the kinetic energy and hence the speed of the proton have their original values, and the speed is \( 3.00 \times 10^5 \text{ m/s} \).