Conservation of Energy Homework Solutions

p. 197 #6 $h_1 = 0\,m$ $v_1 = 9.7\frac{m}{s}$ $h_2 = 4.7\,m$ $v_2 = ?$

$$E_{T1} = E_{T2}$$

$$\frac{1}{2}m v_1^2 + m g h_1 = \frac{1}{2}m v_2^2 + m g h_2$$

$$\frac{1}{2}v_1^2 + g h_1 = \frac{1}{2}v_2^2 + g h_2$$

$$v_1^2 + 2 g h_1 = v_2^2 + 2 g h_2$$

$$v_1^2 + 2 g h_1 - 2 g h_2 = v_2^2$$

$$v_1^2 + 2 g (h_1 - h_2) = v_2^2$$

$$\sqrt{v_1^2 + 2 g (h_1 - h_2)} = v_2$$

$$\sqrt{\left(9.7\frac{m}{s}\right)^2 + 2\left(9.8\frac{m}{s^2}\right)(0\,m - 4.7\,m)} = v_2$$

$$1.4\frac{m}{s} = v_2$$

p. 200 #13 $m = 22.0\,kg$ $F_A = 98\,N$ $F_k = 87\,N$ $\Delta d = 1.2\,m$

First find the total work done on the cabinet: $W_{total} = W_A + W_k$

$$W_{total} = (F_A \cos 0^o)\Delta d + (F_k \cos 180^o)\Delta d$$

$$W_{total} = (98\,N)(1.2\,m) + (-87\,N)(1.2\,m) = 13.2\,J$$

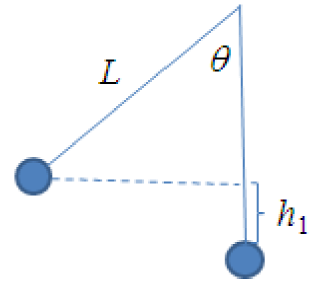
Since $W_{total} = \Delta E_k = \frac{1}{2}m v_2^2 - \frac{1}{2}m v_1^2$

$$v_2 = \sqrt{\frac{2W}{m}} \quad \text{for} \quad v_1 = 0$$

$$v_2 = \sqrt{\frac{2(13.2\,J)}{22.0\,kg}} = 1.1\frac{m}{s}$$

p. 201 #5 First determine the acrobat's initial vertical height above the bottom of the swing:

$$h_1 = L - L\cos\theta = 3.7\,m - (3.7\,m)(\cos 48^o) = 1.224\,m$$



Then: $E_{T1} = E_{T2}$

$$\frac{1}{2}m v_1^2 + m g h_1 = \frac{1}{2} m v_2^2 + m g h_2$$

$$m g h_1 = \frac{1}{2} m v_2^2$$

$$\sqrt{2 g h_1} = v_2$$

$$\sqrt{2(9.8\frac{m}{s^2})(1.224\,m)} = v_2$$

$$4.9\frac{m}{s} = v_2$$

p. 201 #6 $m = 55\,kg$ $v_1 = 0.657\frac{m}{s}$ $v_2 = 7.19\frac{m}{s}$ $\Delta d = 11.7\,m$ $F_k = 41.5\,N$

First determine the skier's change in kinetic energy:

$$\Delta E_k = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2 = \frac{1}{2}(55\,kg)(7.19\frac{m}{s})^2 - \frac{1}{2}(55\,kg)(0.657\frac{m}{s})^2 = 1409.8\,J$$

This is equal to the change in gravitational potential plus the work done by friction:

$$\Delta E_k = m g h + (F_k \cos 180^o)\Delta d$$

So $$h = \frac{\Delta E_k - (F_k \cos 180^o)\Delta d}{m g} = \frac{1409.8\,J - (41.5\,N)(-1)(11.7\,m)}{(55\,kg)(9.8\frac{m}{s^2})} = 3.5164\,m$$

$$\phi = \sin^{-1}(\frac{3.5164\,m}{11.7\,m}) = 17.5^o$$