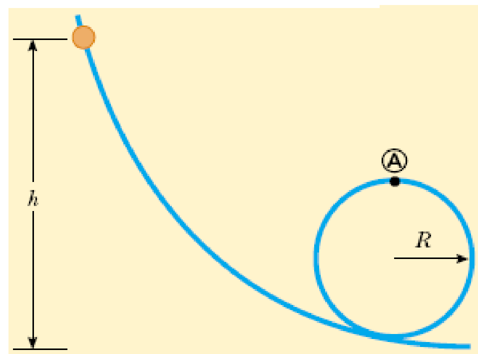
Chapter 8

5. A bead slides without friction around a loop-the-loop (Fig. P8.5). The bead is released from a height $h = 3.50R$. (a) What is its speed at point Ⓐ? (b) How large is the normal force on it if its mass is 5.00 g?



$$U_i + K_i = U_f + K_f: \qquad mgh + 0 = mg(2R) + \frac{1}{2}mv^2$$

$$g(3.50R) = 2g(R) + \frac{1}{2}v^2$$

$$\boxed{v = \sqrt{3.00gR}}$$

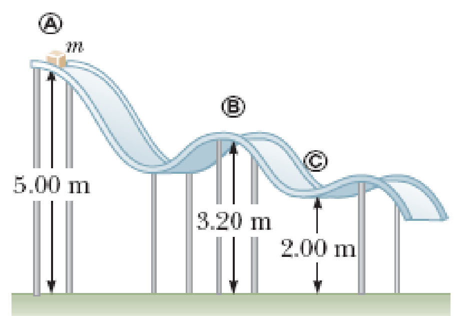
$$\sum F = m\frac{v^2}{R}: \quad n + mg = m\frac{v^2}{R}$$

$$n = m\left[\frac{v^2}{R} - g\right] = m\left[\frac{3.00gR}{R} - g\right] = 2.00mg$$

$$n = 2.00(5.00 \times 10^{-3}\ \text{kg})(9.80\ \text{m/s}^2)$$

$$= \boxed{0.098\,0\ \text{N downward}}$$

6. A block of mass m = 5.00 kg is released from point Ⓐ and slides on the frictionless track shown in Figure P8.6. Determine (a) the block's speed at points Ⓑ and Ⓒ and (b) the net work done by the gravitational force on the block as it moves from point Ⓐ to point Ⓒ.



(a) $$(\Delta K)_{A\to B} = \sum W = W_g = mg\Delta h = mg(5.00 - 3.20)$$

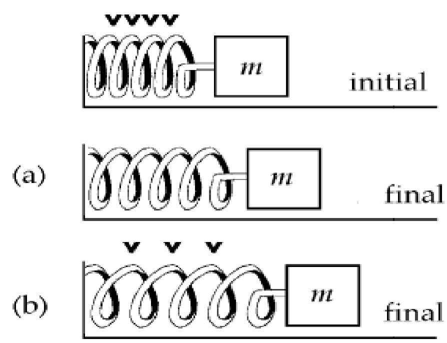
$$\frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2 = m(9.80)(1.80)$$

$$v_B = \boxed{5.94\ \text{m/s}}$$

Similarly, $v_C = \sqrt{v_A^2 + 2g(5.00 - 2.00)} = \boxed{7.67\ \text{m/s}}$

(b) $$W_g\Big|_{A\to C} = mg(3.00\ \text{m}) = \boxed{147\ \text{J}}$$

7. A glider of mass 0.150 kg moves on a horizontal frictionless air track. It is permanently attached to one end of a massless horizontal spring, which has a force constant of 10.0 N/m both for extension and for compression. The other end of the spring is fixed. The glider is moved to compress the spring by 0.180 m and then released from rest. Calculate the speed of the glider (a) at the point where it has moved 0.180 m from its starting point, so that the spring is momentarily exerting no force and (b) at the point where it has moved 0.250 m from its starting point.



(a)
$$\frac{1}{2}mv_i^2+\frac{1}{2}kx_i^2=\frac{1}{2}mv_f^2+\frac{1}{2}kx_f^2$$
$$0+\frac{1}{2}(10\ \text{N/m})(-0.18\ \text{m})^2=\frac{1}{2}(0.15\ \text{kg})v_f^2+0$$
$$v_f=(0.18\ \text{m})\sqrt{\left(\frac{10\ \text{N}}{0.15\ \text{kg}\cdot\text{m}}\right)\left(\frac{1\ \text{kg}\cdot\text{m}}{1\ \text{N}\cdot\text{s}^2}\right)}=\boxed{1.47\ \text{m/s}}$$

(b)
$$K_i+U_{si}=K_f+U_{sf}$$
$$0+\frac{1}{2}(10\ \text{N/m})(-0.18\ \text{m})^2=\frac{1}{2}(0.15\ \text{kg})v_f^2+\frac{1}{2}(10\ \text{N/m})(0.25\ \text{m}-0.18\ \text{m})^2$$
$$0.162\ \text{J}=\frac{1}{2}(0.15\ \text{kg})v_f^2+0.0245\ \text{J}$$
$$v_f=\sqrt{\frac{2(0.138\ \text{J})}{0.15\ \text{kg}}}=\boxed{1.35\ \text{m/s}}$$

7. Two objects are connected by a light string passing over a light, frictionless pulley as shown in Figure P8.7. The object of mass $m_1 = 5.00$ kg is released from rest at a height $h = 4.00$ m above the table. Using the isolated system model, (a) determine the speed of the object of mass $m_2 = 3.00$ kg just as the 5.00-kg object hits the table and (b) find the maximum height above the table to which the 3.00-kg object rises.

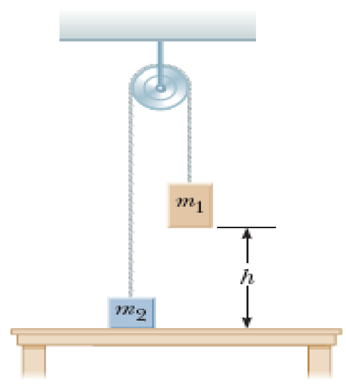


Figure P8.7
Problems 7 and 8.

Using conservation of energy for the system of the Earth and the two objects

(a) $$(5.00\text{ kg})g(4.00\text{ m}) = (3.00\text{ kg})g(4.00\text{ m}) + \frac{1}{2}(5.00 + 3.00)v^2$$

$$v = \sqrt{19.6} = \boxed{4.43\text{ m/s}}$$

(b) Now we apply conservation of energy for the system of the 3.00 kg object and the Earth during the time interval between the instant when the string goes slack and the instant at which the 3.00 kg object reaches its highest position in its free fall.

$$\frac{1}{2}(3.00)v^2 = mg\,\Delta y = 3.00g\Delta y$$

$$\Delta y = 1.00\text{ m}$$

$$y_{\text{max}} = 4.00\text{ m} + \Delta y = \boxed{5.00\text{ m}}$$