29. Equation 14-13 combined with Eq. 5-8 and Eq. 7-21 (in absolute value) gives

$$mg = kx \frac{A_1}{A_2} \ .$$

With $A_2 = 18A_1$ (and the other values given in the problem) we find m = 8.50 kg.

6. We use Eq. 7-12 for W_g and Eq. 8-9 for U.

(a) The displacement between the initial point and Q has a vertical component of $h - R$ downward (same direction as $\vec{F}_g$), so (with $h = 5R$) we obtain

$$W_g = \vec{F}_g \cdot \vec{d} = 4mgR = 4(3.20\times10^{-2}\text{ kg})(9.80\text{ m/s}^2)(0.12\text{ m}) = 0.15\text{ J}.$$

(b) The displacement between the initial point and the top of the loop has a vertical component of $h - 2R$ downward (same direction as $\vec{F}_g$), so (with $h = 5R$) we obtain

$$W_g = \vec{F}_g \cdot \vec{d} = 3mgR = 3(3.20\times10^{-2}\text{ kg})(9.80\text{ m/s}^2)(0.12\text{ m}) = 0.11\text{ J}.$$

(c) With $y = h = 5R$, at P we find

$$U = 5mgR = 5(3.20\times10^{-2}\text{ kg})(9.80\text{ m/s}^2)(0.12\text{ m}) = 0.19\text{ J}.$$

(d) With $y = R$, at Q we have

$$U = mgR = (3.20\times10^{-2}\text{ kg})(9.80\text{ m/s}^2)(0.12\text{ m}) = 0.038\text{ J}.$$

(e) With $y = 2R$, at the top of the loop, we find

$$U = 2mgR = 2(3.20\times10^{-2}\text{ kg})(9.80\text{ m/s}^2)(0.12\text{ m}) = 0.075\text{ J}.$$

(f) The new information $(v_i \neq 0)$ is not involved in any of the preceding computations; the above results are unchanged.

57. Since the valley is frictionless, the only reason for the speed being less when it reaches the higher level is the gain in potential energy $\Delta U = mgh$ where h = 1.1 m. Sliding along the rough surface of the higher level, the block finally stops since its remaining kinetic energy has turned to thermal energy $\Delta E_{\text{th}} = f_k d = \mu mgd$, where $\mu = 0.60$. Thus, Eq. 8-33 (with W = 0) provides us with an equation to solve for the distance d:

$$K_i = \Delta U + \Delta E_{\text{th}} = mg\left(h + \mu d\right)$$

where $K_i = mv_i^2/2$ and v_i = 6.0 m/s. Dividing by mass and rearranging, we obtain

$$d = \frac{v_i^2}{2\mu g} - \frac{h}{\mu} = 1.2\text{ m}.$$

64. In the absence of friction, we have a simple conversion (as it moves along the inclined ramps) of energy between the kinetic form (Eq. 7-1) and the potential form (Eq. 8-9). Along the horizontal plateaus, however, there is friction that causes some of the kinetic energy to dissipate in accordance with Eq. 8-31 (along with Eq. 6-2 where μ_k = 0.50 and $F_N = mg$ in this situation). Thus, after it slides down a (vertical) distance d it has gained $K = \frac{1}{2} mv^2 = mgd$, some of which ($\Delta E_{\text{th}} = \mu_k\, mgd$) is dissipated, so that the value of kinetic energy at the end of the first plateau (just before it starts descending towards the lowest plateau) is

$$K = mgd - \mu_k mgd = \frac{1}{2} mgd \ .$$

In its descent to the lowest plateau, it gains $mgd/2$ more kinetic energy, but as it slides across it "loses" $\mu_k\, mgd/2$ of it. Therefore, as it starts its climb up the right ramp, it has kinetic energy equal to

$$K = \frac{1}{2} mgd + \frac{1}{2} mgd - \frac{1}{2}\mu_k mgd = \frac{3}{4} mgd \ .$$

Setting this equal to Eq. 8-9 (to find the height to which it climbs) we get $H = ¾d$. Thus, the block (momentarily) stops on the inclined ramp at the right, at a height of

$$H = 0.75d = 0.75\,(40 \text{ cm}) = 30 \text{ cm}$$

measured from the lowest plateau.

31. The reference point for the gravitational potential energy U_g (and height h) is at the block when the spring is maximally compressed. When the block is moving to its highest point, it is first accelerated by the spring; later, it separates from the spring and finally reaches a point where its speed v_f is (momentarily) zero. The x axis is along the incline, pointing uphill (so x_0 for the initial compression is negative-valued); its origin is at the relaxed position of the spring. We use SI units, so k = 1960 N/m and x_0 = –0.200 m.

(a) The elastic potential energy is $\frac{1}{2}kx_0^2 = 39.2\text{ J}$.

(b) Since initially U_g = 0, the change in U_g is the same as its final value mgh where m = 2.00 kg. That this must equal the result in part (a) is made clear in the steps shown in the next part. Thus, $\Delta U_g = U_g$ = 39.2 J.

(c) The principle of mechanical energy conservation leads to

$$K_0 + U_0 = K_f + U_f$$
$$0 + \frac{1}{2}kx_0^2 = 0 + mgh$$

which yields h = 2.00 m. The problem asks for the distance *along the incline*, so we have $d = h/\sin 30°$ = 4.00 m.

32. The work required is the change in the gravitational potential energy as a result of the chain being pulled onto the table. Dividing the hanging chain into a large number of infinitesimal segments, each of length dy, we note that the mass of a segment is $(m/L)\,dy$ and the change in potential energy of a segment when it is a distance $|y|$ below the table top is

$$\Delta U = -\frac{mg}{L}\int_{-L/4}^{0} y\,dy = \frac{1}{2}\frac{mg}{L}(L/4)^2 = mgL/32.$$

The work required to pull the chain onto the table is therefore

$$W = \Delta U = mgL/32 = (0.012\text{ kg})(9.8\text{ m/s}^2)(0.28\text{ m})/32 = 0.0010\text{ J}.$$