60. This can be worked entirely by the methods of Chapters 2-6, but we will use energy methods in as many steps as possible.

(a) By a force analysis of the style done in Ch. 6, we find the normal force has magnitude $N = mg\cos\theta$ (where $\theta = 40°$) which means $f_k = \mu_k mg\cos\theta$ where $\mu_k = 0.15$. Thus, Eq. 8-29 yields $\Delta E_{\text{th}} = f_k d = \mu_k mgd\cos\theta$. Also, elementary trigonometry leads us to conclude that $\Delta U = mgd\sin\theta$. Eq. 8-31 (with $W = 0$ and $K_f = 0$) provides an equation for determining d:

$$\begin{aligned} K_i &= \Delta U + \Delta E_{\text{th}} \\ \frac{1}{2}mv_i^2 &= mgd\left(\sin\theta + \mu_k\cos\theta\right) \end{aligned}$$

where $v_i = 1.4$ m/s. Dividing by mass and rearranging, we obtain

$$d = \frac{v_i^2}{2g\left(\sin\theta + \mu_k\cos\theta\right)} = 0.13 \text{ m} .$$

(b) Now that we know where on the incline it stops ($d' = 0.13 + 0.55 = 0.68$ m from the bottom), we can use Eq. 8-31 again (with $W = 0$ and now with $K_i = 0$,) to describe the final kinetic energy (at the bottom):

$$\begin{aligned} K_f &= -\Delta U - \Delta E_{\text{th}} \\ \frac{1}{2}mv^2 &= mgd'\left(\sin\theta - \mu_k\cos\theta\right) \end{aligned}$$

which – after dividing by the mass and rearranging – yields

$$v = \sqrt{2gd'\left(\sin\theta - \mu_k\cos\theta\right)} = 2.7 \text{ m/s} .$$

(c) In part (a) it is clear that d increases if μ_k decreases – both mathematically (since it is a positive term in the denominator) and intuitively (less friction – less energy "lost"). In part (b), there are two terms in the expression for v which imply that it should increase if μ_k were smaller: the increased value of $d' = d_0 + d$ and that last factor $\sin\theta - \mu_k\cos\theta$ which indicates that less is being subtracted from $\sin\theta$ when μ_k is less (so the factor itself increases in value).