

Elementary Dynamics Example #19: (Work & Energy)

Given: $m = 50$ (kg), $k = 35$ (kN/m), $\mu_k = 0.3$,
spring is **unstretched** when $s = 0$,
 $v = 5$ (m/s) when $s = 0$

Find: $s_{\max}$, the maximum displacement of the mass to the right.

Solution:

Newton's 2nd Law:

$$+\uparrow \sum F = N - mg = 0 \Rightarrow f = \mu_k N = 0.3mg$$

Work & Energy:

$$K_1 + U_{1 \rightarrow 2} = \underbrace{K_2}_{\text{zero}}$$

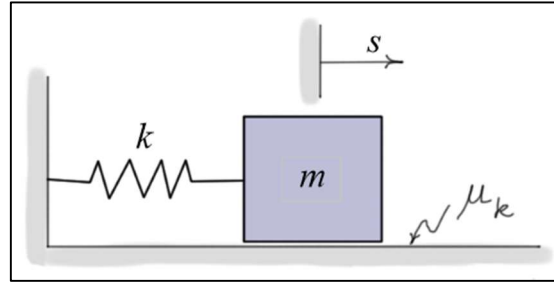
where

$$K_1 = \frac{1}{2}mv_1^2 = \frac{50}{2}(5^2) = 25^2 = 625 \text{ (N-m)}$$

$$U_{1 \rightarrow 2} = -\frac{1}{2}ks_{\max}^2 - fs_{\max} = -17500s_{\max}^2 - 0.3mgs_{\max} = -17500s_{\max}^2 - 147.15s_{\max}$$

Substituting into the work & energy equation

$$17500s_{\max}^2 + 147.15s_{\max} - 625 = 0 \Rightarrow s_{\max} \approx \begin{cases} 0.185 \text{ (m)} \\ -0.193 \text{ (m)} \end{cases} \Rightarrow s_{\max} \approx 0.185 \text{ (m)}$$



Free body diagram

