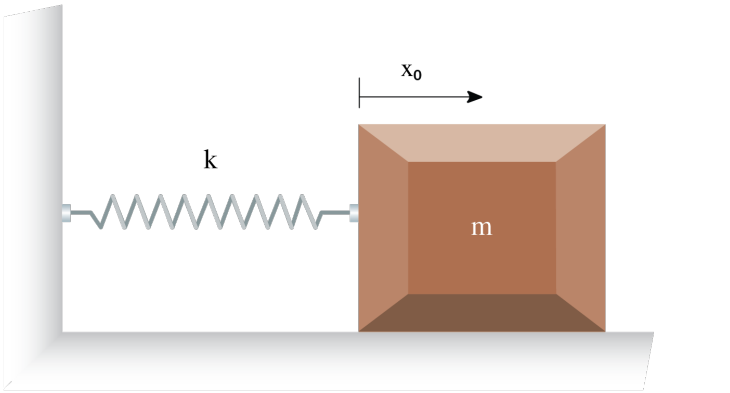
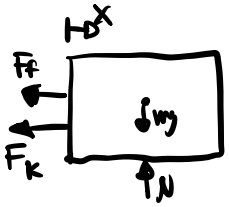
A box of mass $m = 5kg$ is connected to a spring, $k = 200N/m$ on the wall. The ground has a static and kinetic friction coefficient $\mu = 0.2$. Given an initial displacement of 1m, determine how long it takes to come to a stop.



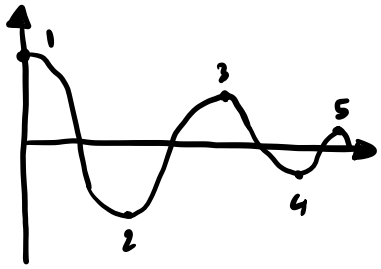
FBD



$$-F_f - F_K = m\ddot{x} \quad \Rightarrow \quad m\ddot{x} + \mu mg + Kx = 0$$

$$x(t) = \left(x_0 - \frac{(2n-1)\mu mg}{K}\right)\cos\omega_n t + \frac{\mu mg}{K}(-1)^{(n+1)}$$

n = every peak



$$F_f > F_K \quad \Rightarrow \quad \mu mg > |Kx(t)|$$

$$\frac{\mu mg}{K} > \left| \left(x_0 - \frac{\mu mg}{K}(2n-1)\cos \omega_n t + \frac{\mu mg}{K}(-1)^{(n+1)} \right) \right|$$

$$0.04905 > \left| \left(x_0 - 0.04905(2n-2) \right) \right|$$

$\therefore x_0 = 1\,m \Rightarrow n = 11$

$\therefore$ 5 full cycles (periods)

$\omega_n t = 10\pi$ $\qquad$ $\omega_n = \sqrt{\frac{K}{m}} = \sqrt{40}\ rad/s$

$$\boxed{t = \frac{10\pi}{\sqrt{40}}\ sec}$$