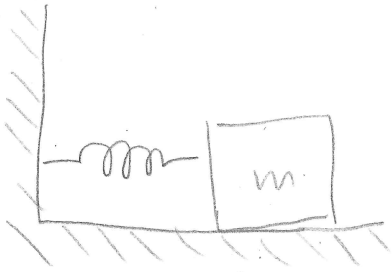
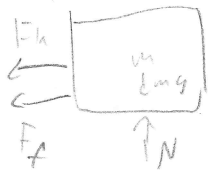
20-R-VIB-DY-26 Beginner

A box of mass $m = 5kg$ is connected to a spring, $k = 20 N/m$ on the wall. The ground has a friction coefficient of $\mu = 0.2$. Given an initial displacement of 0.1 m, determine how long it takes to come to a stop.



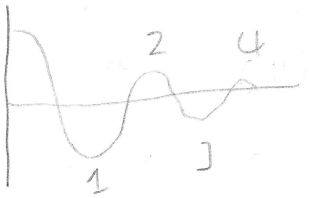
FBD:



$F_f > F_k$ at stop

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

n = every half period



has to stop at peak because $f_{static} > f_{kinetic}$

$$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{40}$$

$$\mu mg > kx(t)$$

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

$$0.04905 > (0.1 - 0.04905(2n-1))\cos\sqrt{40}\,t + 0.04905(-1)^{(n+1)}$$

$n = 1$, $x(t) = 0.0019$

$n = 2$, $x(t) = 0.0962$

$n = 2$ → $\sqrt{40}t = 2\pi$ $t = \frac{\sqrt{40}}{2\pi}$

one full period, 2π