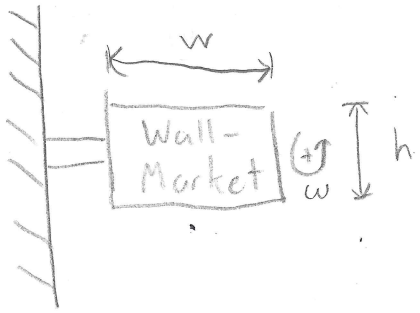
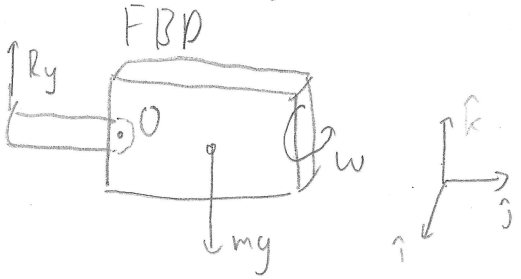
20-R-VIB-DY-4

A store's sign is mounted horizontally from a wall. The sign can be thought of as a thin rectangle with a height of 0.5m, length 1m, and density 100 kg/m². The pole the sign is mounted to has a spring constant of 10N/rad. Due to a particularly strong gust of wind, the sign experiences an initial angular velocity $\omega_0 = 2$ rad/s. What is the maximum angle displacement of the sign?



Solution:



$\Sigma M_O = -I_O \alpha$

$k\theta = -I_O \alpha$

$I_O \ddot{\theta} + k\theta = 0$

$m = wxh\rho = 50kg$

$I_O = \frac{1}{12} m(h^2) = \frac{1}{12}(50)(0.5)^2$

$= 1.042$

$\omega_n = \sqrt{\frac{k}{I_O}} = 3.098$ rad/s

$\theta(t) = A\sin\omega_n t + B\cos\omega_n t$

$\dot{\theta}(t) = B\omega_n \sin\omega_n t + A\omega_n \cos\omega_n t$

$0 = B\cos\omega_n t \quad B = 0$

$2 = A\omega_n \quad A = \frac{2}{\omega_n} = 0.646$

$\theta(t) = \underbrace{0.646}_{\text{maximum amplitude}} \sin 3.098t$