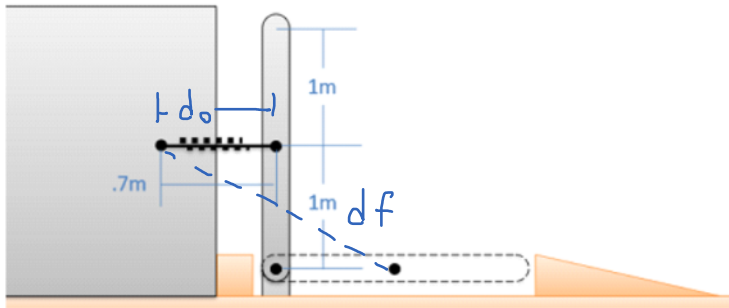


Problem 2

A system as shown below is used to passively slow the lowering of a gate. The gate can be approximated as a flat plate on it's edge with a mass of 25 kg and a height of 2m. Assume the spring is unstretched as shown in the diagram.

- What would the angular velocity of the gate be without the spring?
- If we want to reduce the angular velocity at the bottom to 25% of it's original value what should the spring constant be?



$$d_o = 0.7 \text{ m}$$

$$d_f = \sqrt{1^2 + 1.7^2} = 1.97 \text{ m}$$

a)

$$W = \Delta KE + \Delta PE$$

$$0 = \frac{1}{2} I_o \omega_f^2 - \frac{1}{2} I_o \omega_i^2 - m g \Delta h$$

$$I_o = \frac{1}{12} m l^2 + m r^2 = \frac{1}{12} (25)(2\text{m})^2 + (25)(1\text{m})^2 = 33.33 \text{ kg m}^2$$

$$0 = \frac{1}{2} (33.33 \text{ kg m}^2) (\omega_f)^2 - (25)(9.81)(-1)$$

$$\omega_f^2 = 3.84 \text{ rad/s}$$

b)

$$\frac{\omega_f}{4} = .96 \text{ rad/s}$$

$$W = \Delta KE + \Delta PE$$

$$Q = \frac{1}{2} I_o (.96 \text{ rad/s})^2 - m g \Delta h + \frac{1}{2} k x_f^2 - \frac{1}{2} k x_i^2$$

$$Q = \frac{1}{2} (33.33) (.96)^2 - (25)(9.81)(-1) + \frac{1}{2} (k) (1.97-.7)^2$$

$$Q = 15.32 - 245.25 + \frac{1}{2} (1.27)^2 k$$

$$\boxed{k = 285.1 \text{ N/m}}$$