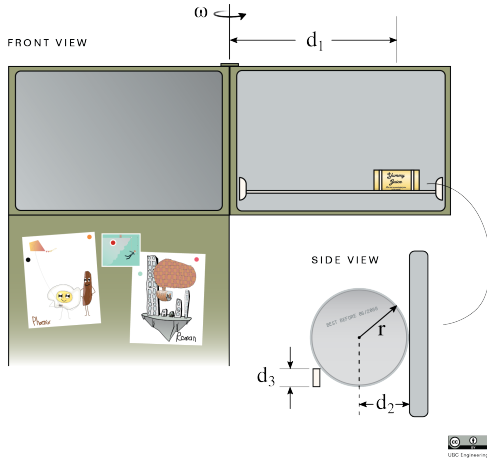# 22-R-IM-TW-30

A 1.5 kg can of concentrated orange juice is sitting on the side of a freezer door as shown. If the can of juice has a radius of 3 cm and is at a distance $d_1 = 0.3$ m away from the hinge of the freezer, what is the maximum angular speed you can open the freezer door with without having the juice hop the 0.9 cm ledge labelled d_3 and fall out of the freezer?

Solution:

$$I_G = \frac{1}{2}mr^2 = \frac{1}{2}(1.5)(0.03)^2 = 6.75 \times 10^{-4} \; [\text{kg} \cdot \text{m}^2]$$

$$H_{A,1} = H_{A,2}$$

$$H_{A,1} = (r - d_3)mv_1$$

$$H_{A,2} = I_G\omega_2 + rmv_2$$

$$\frac{1}{2}mv_2^2 = mgd_3$$

$$v_2 = \sqrt{2gd_3} = \sqrt{2(9.81)(0.009)} = 0.42 \; [\text{m/s}]$$

$$v_2 = \omega_2 r \Rightarrow \omega_2 = \frac{v_2}{r} = \frac{0.42}{0.03} = 14 \; [\text{rad/s}]$$

$$H_{A,2} = (6.75 \times 10^{-4})(14) + (0.03)(1.5)(0.42) = 0.0284 \; [\text{kg} \cdot \text{rad/s}]$$

$$(r - d_3)mv_1 = H_{A,2}$$

$$v_1 = \frac{H_{A,2}}{m(r - d_3)} = \frac{0.0284}{(1.5)(0.03 - 0.009)} = 0.90 \; [\text{m/s}]$$

$$v_1 = \omega_1 d_1 \Rightarrow \omega_1 = \frac{v_1}{d_1} = \frac{0.9}{0.3} = 3.0 \; [\text{rad/s}]$$