20-R-IM-PT-4

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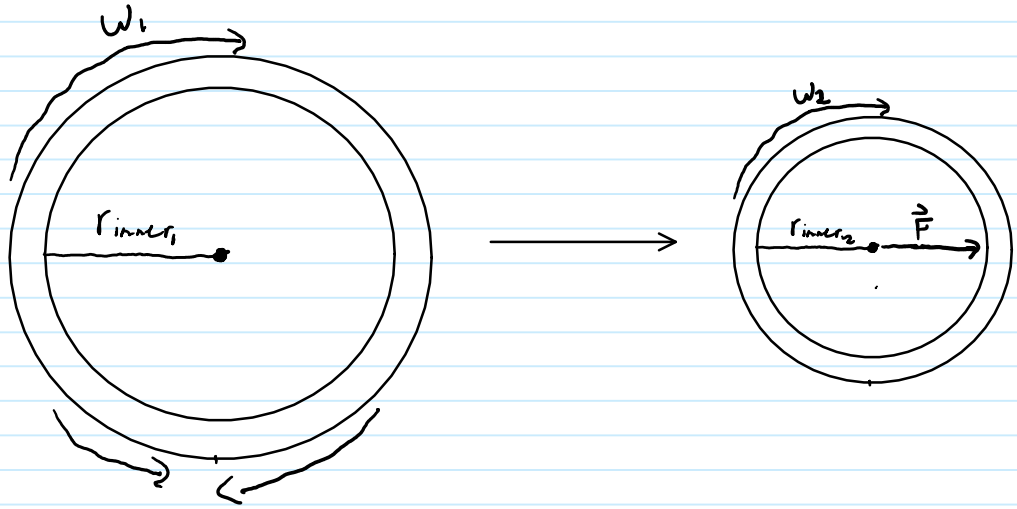
A circular space station, shown below, is built with a retracting feature. If the station rotates fast enough, artificial gravity can be created from centripetal acceleration. The space station is similar to a thin ring, with an initial radius of 72 m, a mass of 500,000kg and an initial angular speed of 0.1 radians per second. What radius should it retract to for artificial gravity?



Solution

$a_c = \omega^2 r_{inner_2} = g = 9.81\ m/s^2$

$r_{inner_1} = 72\ m \quad \omega_1 = 0.1$

$m = 500{,}000\ kg$

$r_{inner_2} = \frac{9.81}{\omega^2}$

$H_1 = H_2$

$I_1 = m r_{inner_1}^2$

$I_2 = m r_{inner_2}^2$

$I_1 \omega_1 = I_2 \omega_2$

$m r_{inner_1}^2 \omega_1 = m r_{inner_2}^2 \omega_2$

$(72^2)(0.1) = \left(\frac{9.81}{\omega_2^2}\right)^2 \omega_2$

$518.4 = \frac{9.81^2}{\omega_2^3}$

$\omega_2^3 = \frac{9.81^2}{518.4}$

$\omega_2 = \sqrt[3]{\frac{9.81^2}{518.4}}$

$\omega_2 = 0.570\ rad/s$

$r_{inner_2} = \frac{9.81}{(0.57)^2} = 30.1939$

The ship should retract to a radius of 30.19m