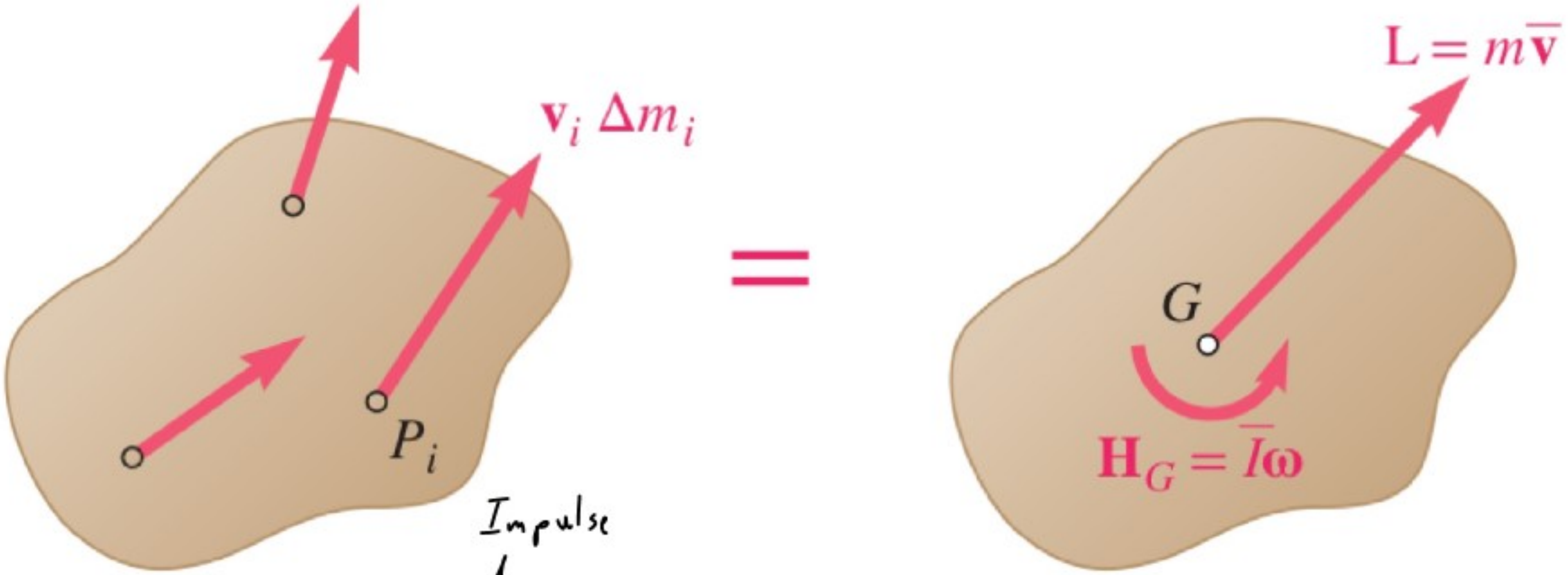
Momentum for Rigid Bodies

$$\vec{L}_1 + \vec{Imp}_{1\to 2} = \vec{L}_2$$

$$\vec{L} = \sum_{i=1}^{n} \vec{V}_i \Delta m_i = \int \vec{V}\, dm$$

$$\vec{H}_G = \sum_{i=1}^{n} \vec{r}_i{}' \times \vec{V}_i \Delta m_i = \int \vec{r}\,' \times \vec{V}\, dm$$

r' vector from center of mass



$$\vec{H}_0 = I_0\vec{w}$$

$$\vec{H}_{01} + \overbrace{\int_{t_1}^{t_2}\vec{M}_0\,dt}^{\text{Impulse}} = \vec{H}_{02}$$

$\vec{H}_{01} + \vec{M}_0\Delta t = \vec{H}_{02}$ if M_0 is constant

The rotor of an electric motor has a mass of 25 kg, and it is observed that 4.2 min is required for the rotor to coast to rest from an angular velocity of 3600 rpm. Knowing that kinetic friction produces a couple of magnitude 1.2 N·m, determine the centroidal radius of gyration for the rotor.

$$H_{o1} + M_o \Delta t = \cancel{H_{o2}}^{0}$$

$$H_{o1} = I_o w$$

$$= mK^2 w$$

$$I_o = mK^2$$

$$mK^2 w + M_o \Delta t = 0$$

$$mK^2 w = -M_o \Delta t$$

$$K^2 = \frac{-M_o \Delta t}{m w}$$

$$\frac{1.2\ \cancel{N}\text{-m}\ 4.2\ \cancel{min}}{25\ \cancel{kg}\ 3600\ \frac{\cancel{rev}}{\cancel{min}}} \frac{\frac{1\ \cancel{kg}\,m}{\cancel{s^2}}}{1\ \cancel{N}} \left(\frac{60\ \cancel{s}}{1\ \cancel{min}}\right)^2 \frac{1\ \cancel{rev}}{2\pi\ rad} = 0.032\ m^2 = K^2$$

$$\boxed{K = 0.18\,m}$$

A bolt located 2 in. from the center of an automobile wheel is tightened by applying the couple shown for 0.10 s. Assuming that the wheel is free to rotate and is initially at rest, determine the resulting angular velocity of the wheel. The wheel weighs 42 lb and has a radius of gyration about its mass center of 10.8 in.

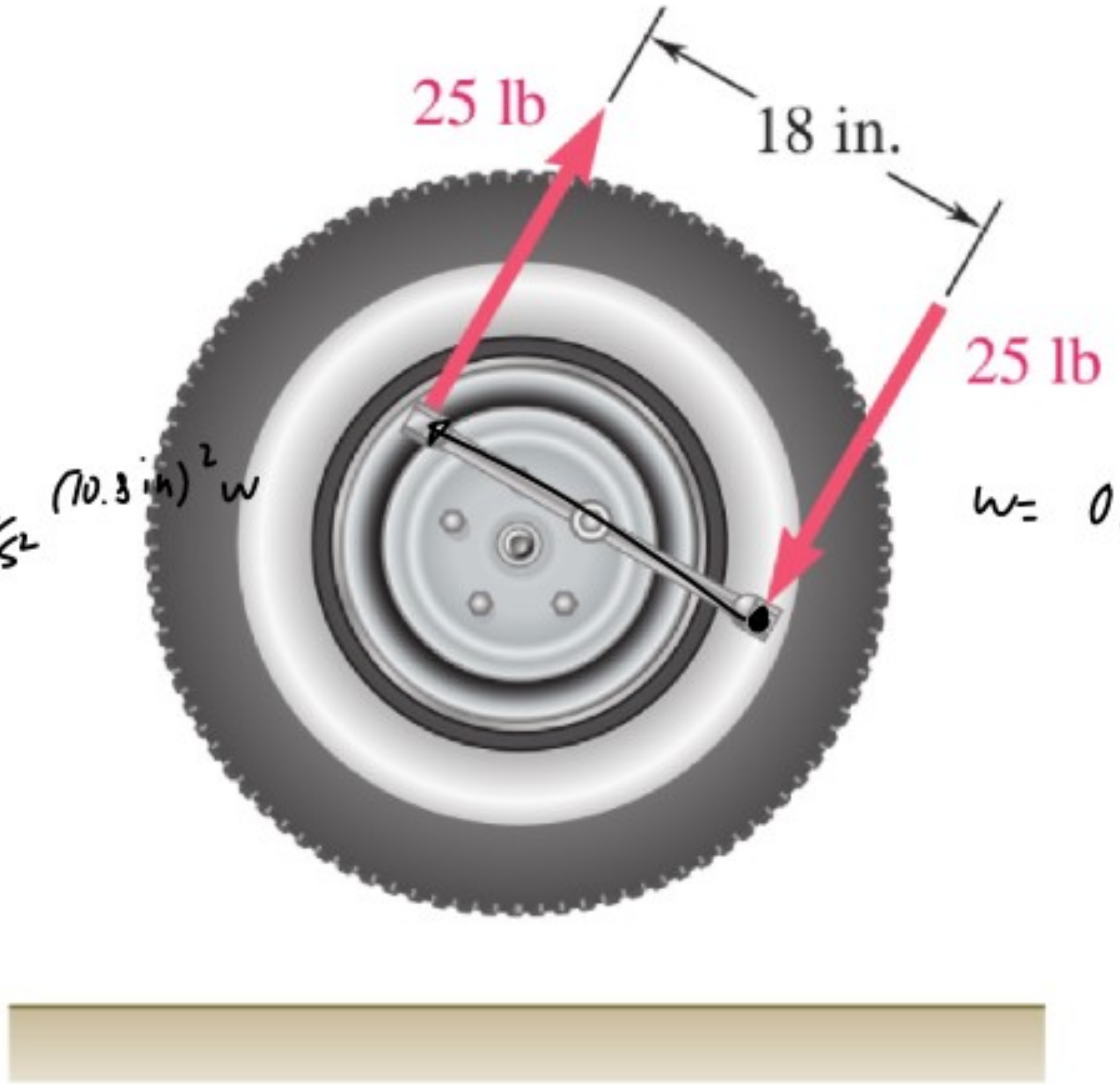
$\cancel{H_{o1}}^{0} + M_o \Delta t = H_{o2}$

$M_o \Delta t = I_o \omega$

$M_o \Delta t = \frac{W}{g} k^2 \omega$

$18 \text{ in } 25 \text{ lb } 0.1 \text{ s} = \frac{42 \text{ lb}}{32.2 \text{ ft/s}^2} (10.8 \text{ in})^2 \omega$

$\frac{18 \text{ in } 25 \text{ lb } 0.1 \text{ s } 32.2 \text{ ft/s}^2}{42 \text{ lb } (10.8 \text{ in})^2}$



$I_o = mk^2$

$= \frac{W}{g} k^2$

$\omega = 0.296 \frac{\text{ft}}{\text{in s}} \frac{12 \text{ in}}{1 \text{ ft}} = \boxed{3.55 \text{ rad/s}}$