Momentum for Rigid Bodies

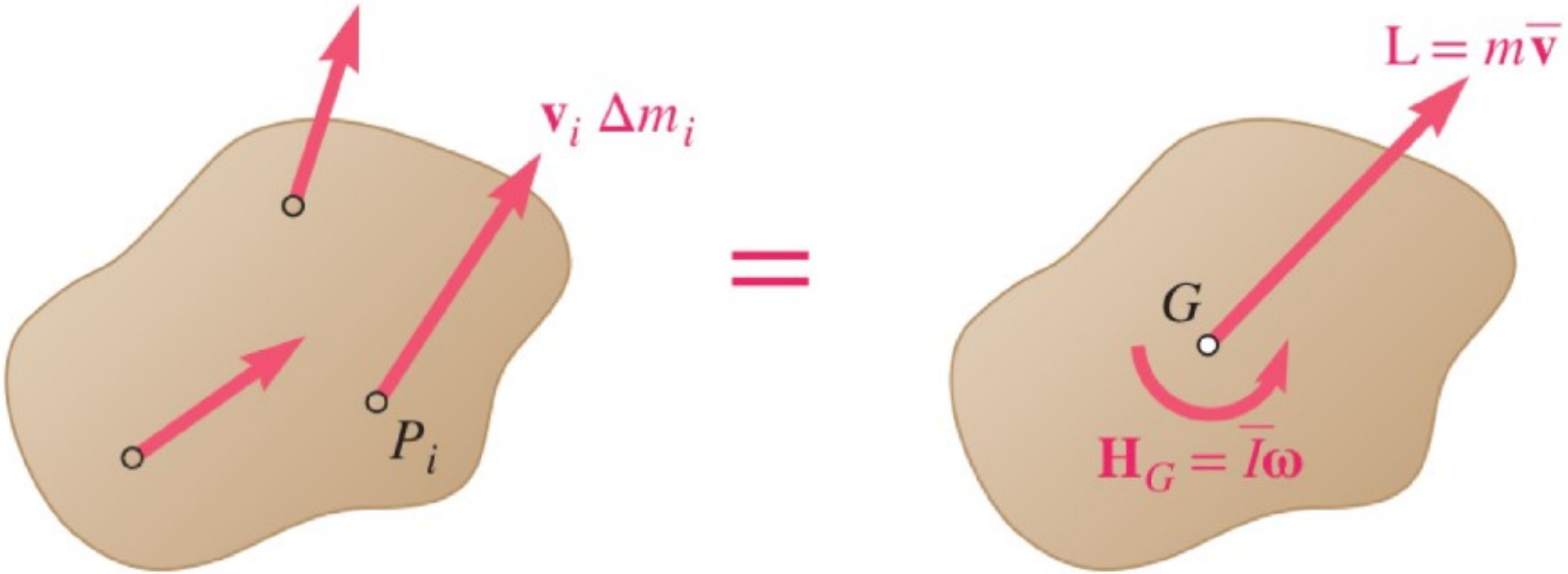
$$L_1 + Imp_{1\to 2} = L_2$$

$$H_G = \sum_{i=1}^{n} r_i' \times v_i \Delta m_i = \int r' \times v \, dm \qquad H_o = I_o w$$

$$H_{o1} + \sum \int_{t_1}^{t_2} M_o \, dt = H_{o2}$$

if M_o constant

$$H_{o1} + \sum M_o \Delta t = H_{o2}$$



$\mathbf{v}_i \, \Delta m_i$
P_i
=
$\mathbf{L} = m\overline{\mathbf{v}}$
G
$\mathbf{H}_G = \overline{I}\boldsymbol{\omega}$

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.

$I = mK^2$

$H_1 + \tau \Delta t = H_2 \rightarrow 0$

$I\omega = -\tau \Delta t$

$mK^2\omega = -\tau \Delta t \Rightarrow K^2 = \frac{-\tau \Delta t}{m\omega} = \frac{1.2\ N\cdot m \quad 4.2\ min}{25\ Kg \quad 3600\ \frac{rev}{min}} = 5.6\times10^{-5}\ \frac{N\,m\ min^2}{Kg\ rev} = 5.6\times10^{-5}\ \frac{Kg\ m^2\ min^2}{Kg\ s^2\ rev}\left(\frac{60\ sec}{1\ min}\right)^2$

$= 0.2\ \frac{m^2}{rev}\ \frac{1\ rev}{2\pi\ rad} = 0.032\ m^2$

$K = 0.179\ m$

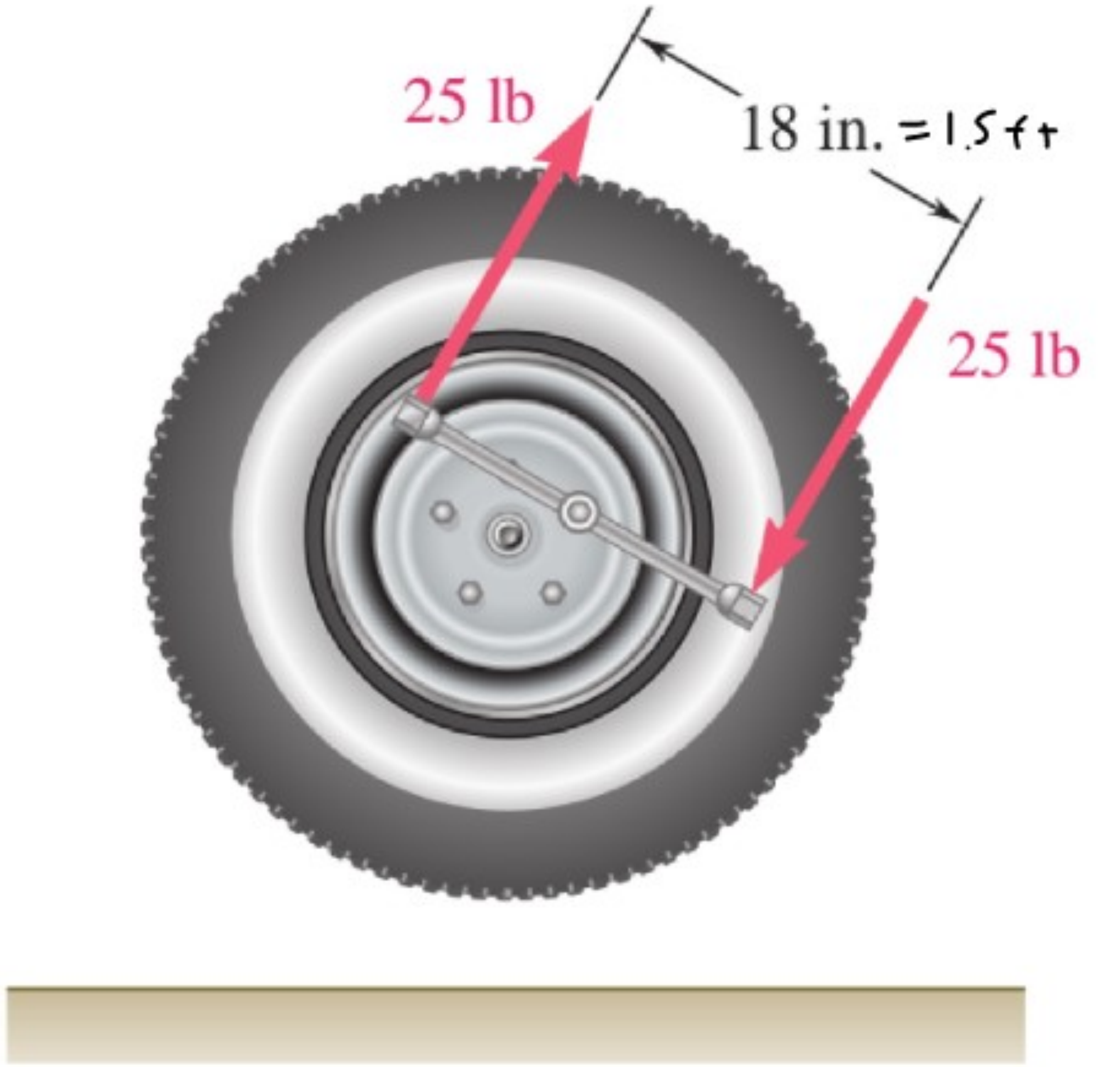
A bolt located 2 in. from the center of an automobile wheel is tightened by applying the couple shown for 0.10 s. Assuming that the wheel is free to rotate and is initially at rest, determine the resulting angular velocity of the wheel. The wheel weighs 42 lb and has a radius of gyration about its mass center of 10.8 in. = 0.9 ft

$H_1 + M\Delta t = H_2$ ($H_1 = 0$)

$-25\text{ lb}\ 1.5\text{ ft}\ 0.1\text{ s} = I\omega$

$\dfrac{-25\text{ lb}\ 1.5\text{ ft}\ 0.1\text{ s}}{I} = \omega$

$\dfrac{-25\text{ lb}\ 1.5\text{ ft}\ 0.1\text{ s}}{1.053\text{ lb s}^2\text{ ft}} = 3.56\ \text{rad/s}$

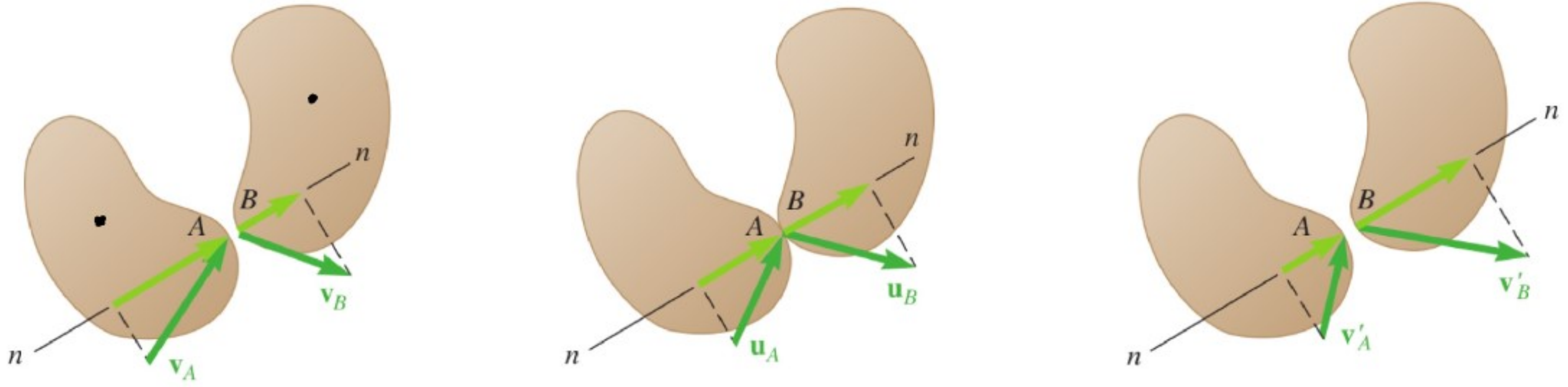


$\dfrac{42\text{ lb}}{32.2\text{ ft/s}^2} = 1.3\ \dfrac{\text{lb s}^2}{\text{ft}}$

$I = mk^2 = 1.3\dfrac{\text{lb s}^2}{\text{ft}}(0.9\text{ ft})^2$

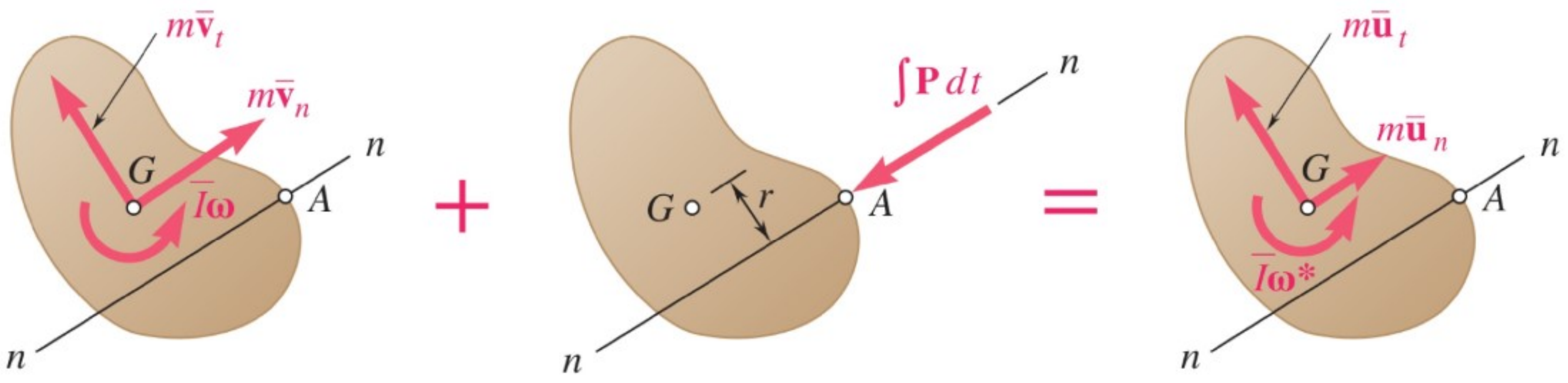
$= 1.053\text{ lb s}^2\text{ ft}$

Eccentric Impact



(a) (b) (c)

$$(v'_B)_n - (v'_A)_n = e\left((v_A)_n - (v_B)_n\right)$$



$m\bar{\mathbf{v}}_t$
$m\bar{\mathbf{v}}_n$
G
$\bar{I}\boldsymbol{\omega}$
A
n
n
+
$\int \mathbf{P}\, dt$
n
G
r
A
n
=
$m\bar{\mathbf{u}}_t$
$m\bar{\mathbf{u}}_n$
G
A
$\bar{I}\boldsymbol{\omega}^*$
n
n

A 45-g bullet is fired with a velocity of 400 m/s at $\theta = 30°$ into a 9-kg square panel of side $b = 200$ mm. Knowing that $h = 150$ mm and that the panel is initially at rest, determine (*a*) the velocity of the center of the panel immediately after the bullet becomes embedded, (*b*) the impulsive reaction at *A*, assuming that the bullet becomes embedded in 2 ms.