

Exercises in Physics  
Assignment # 13

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P1.

$$v_{A\perp} = \sin 54^\circ v_A = 3.24 \text{ m/s}$$

$$L = mvr = 3.24 \times 0.35 \text{ m} = 1.13 \text{ m}$$

$$1.13 \text{ m} = 0.23 m v_B \sin 65$$

$$v_B \sin 65 = 4.93, v_B = 5.44 \text{ m/s}$$

P2.

$$L = mvr$$

$$v = \omega r$$

$$L = mr^2 \omega$$

$$L_1 = 2mr^2 \omega_1$$

$$L_2 = 2m(2r)^2 \omega_2$$

$$2mr^2 \omega_1 = 2m4r^2 \omega_2$$

$$r^2 \omega_1 = 4r^2 \omega_2$$

$$\omega_1 = 4\omega_2$$

$$\omega_2 = \frac{1}{4} \omega_1$$

$$(E_k)_1 = \frac{1}{2} 2mv^2$$

$$= m(\omega_1 r)^2$$

$$= m\omega_1^2 r^2$$

$$(E_k)_2 = \frac{1}{2} 2mv^2$$

$$= m(\omega_2 2r)^2$$

$$= m\left(\frac{1}{4} \omega_1 2r\right)^2$$

$$= m \frac{1}{16} \omega_1^2 4r^2$$

$$= \frac{1}{4} m\omega_1^2 r^2$$

$$\Delta E_k = m\omega_1^2 r^2 - \frac{1}{4} m\omega_1^2 r^2 = \frac{3}{4} m\omega_1^2 r^2$$

P3.

*center of masses before movement*

$$\begin{aligned} M_1 &= \frac{m_1 l + m_2 \times 0 + m_0 \frac{l}{2}}{m_1 + m_2 + m_0} \\ &= \frac{m_1 l + m_0 \frac{l}{2}}{m_1 + m_2 + m_0} \end{aligned}$$

*center of masses after movement*

$$\begin{aligned} M_2 &= \frac{m_1(l - x_1 + s) + m_2(s + x_2) + m_0\left(\frac{l}{2} + s\right)}{m_1 + m_2 + m_0} \\ \frac{m_1 l + m_0 \frac{l}{2}}{m_1 + m_2 + m_0} &= \frac{m_1(l - x_1 + s) + m_2(s + x_2) + m_0\left(\frac{l}{2} + s\right)}{m_1 + m_2 + m_0} \\ m_1 l + m_0 \frac{l}{2} &= m_1(l - x_1 + s) + m_2(s + x_2) + m_0\left(\frac{l}{2} + s\right) \\ m_1 l + m_0 \frac{l}{2} &= m_1 l - m_1 x_1 + m_1 s + m_2 s + m_2 x_2 + m_0 \frac{l}{2} + m_0 s \\ 0 &= -m_1 x_1 + m_1 s + m_2 s + m_2 x_2 + m_0 s \\ 0 &= s(m_1 + m_2 + m_0) + m_2 x_2 - m_1 x_1 \\ s(m_1 + m_2 + m_0) &= m_1 x_1 - m_2 x_2 \\ s &= \frac{m_1 x_1 - m_2 x_2}{m_1 + m_2 + m_0} \end{aligned}$$

P4.

Using the left most end of the barge as reference point

*center of masses before movement*

$$\begin{aligned} M_1 &= \frac{40m_A + 20m_B}{m_A + m_B} \\ &= \frac{40 \times 2 \times 10^3 + 20 \times 10 \times 10^3}{2 \times 10^3 + 10 \times 10^3} \\ &= 23.33m \end{aligned}$$

$$\begin{aligned} M_2 &= \frac{m_A \times 0 + 20m_B}{m_A + m_B} \\ &= \frac{20 \times 10 \times 10^3}{2 \times 10^3 + 10 \times 10^3} \\ &= 16.67m \end{aligned}$$

$$23.33 - 16.67 = 6.66m$$

The barge moves 6.66m toward the right