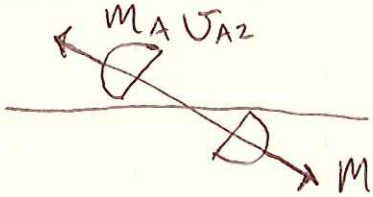
PROB. 14-41

$m_A = 2.5\ kg$, $m_B = 1.5\ kg$, $V_1 = 120\ J$

$\vec{v}_0 = (8)\hat{i}\ \frac{m}{s}$, $\theta = 30°$, FIND v_{A2}, v_{B2}

USE A FRAME OF REFERENCE MOVING WITH THE MASS CENTER.



CONSERVE MOMENTUM:

$$0 = -m_A v_{A2} + m_B v_{B2}$$

$$v_{A2} = \left(\frac{m_B}{m_A}\right) v_{B2}$$

CONSERVE ENERGY:

$$V = \frac{1}{2} m_A v_{A2}^2 + \frac{1}{2} m_B v_{B2}^2$$

$$V = \frac{1}{2} m_A \left(\frac{m_B}{m_A} \cdot v_{B2}\right)^2 + \frac{1}{2} m_B v_{B2}^2$$

$$V = \frac{1}{2} m_B \left(\frac{m_B}{m_A} + 1\right) v_{B2}^2$$

$$V = \frac{1}{2} m_B \left(\frac{m_A + m_B}{m_A}\right) v_{B2}^2$$

$$V = \frac{1}{2} \left(\frac{m_B}{m_A}\right)(m_A + m_B)\, v_{B2}^2$$

$$v_{B2} = \sqrt{\frac{2 m_A V}{m_B (m_A + m_B)}}$$

$$v_{B2} = \sqrt{\frac{2(2.5\ kg)(120\ J)\left(\frac{N \cdot m}{J}\right)\left(\frac{kg \cdot m}{N \cdot s^2}\right)}{(1.5\ kg)(2.5 + 1.5\ kg)}}$$

$$v_{B2} = 10\ \frac{m}{s}$$

PROB. 14-41 CONT.

$$v_{A2} = \left(\frac{1.5}{2.5}\right)(10) = 6 \ \frac{m}{s}$$

$$\vec{v}_A = \vec{v}_G + \vec{v}_{A/G} \quad , \quad \vec{v}_B = \vec{v}_G + \vec{v}_{B/G}$$

$$\vec{v}_{A/G} = (-v_{A2} \cdot \cos 30^\circ)\,\hat{i} + (v_{A2} \cdot \sin 30^\circ)\,\hat{j}$$

$$\vec{v}_{A/G} = (-6 \cdot 0.866)\,\hat{i} + (6 \cdot 0.5)\,\hat{j}$$

$$\vec{v}_{A/G} = (-5.196)\,\hat{i} + (3)\,\hat{j}$$

$$\vec{v}_A = (8)\,\hat{i} + (-5.196)\,\hat{i} + (3)\,\hat{j}$$

$$\vec{v}_A = (2.804)\,\hat{i} + (3)\,\hat{j} \ , \quad \theta = \tan^{-1}\left(\frac{3}{2.804}\right) = 46.93^\circ$$

$$\boxed{\vec{v}_A = 4.106 \ \frac{m}{s} \ \angle 46.93^\circ}$$

$$\vec{v}_{B/G} = (v_{B2} \cdot \cos 30^\circ)\,\hat{i} + (-v_{B2} \cdot \sin 30^\circ)\,\hat{j}$$

$$\vec{v}_{B/G} = (10 \cdot 0.866)\,\hat{i} + (-10 \cdot 0.5)\,\hat{j}$$

$$\vec{v}_{B/G} = (8.66)\,\hat{i} + (-5)\,\hat{j} \ \frac{m}{s}$$

$$\vec{v}_B = (8)\,\hat{i} + (8.66)\,\hat{i} + (-5)\,\hat{j}$$

$$\vec{v}_B = (16.66)\,\hat{i} + (-5)\,\hat{j} \ , \quad \theta = \tan^{-1}\left(\frac{5}{16.66}\right) = 16.70^\circ$$

$$\boxed{\vec{v}_B = 17.39 \ \frac{m}{s} \ \searrow 16.70^\circ}$$