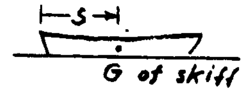
4/13 For entire system $\Delta G_x = 0$, x horiz.

$$(300 + 400 + 100)v - (300 \times 0.6 - 400 \times 0.3 + 100 \times 1.2 \cos 30^\circ) = 0$$

$800v = 163.9$, $v = 0.205$ m/s

Momentum is conserved regardless of sequence of events, so final velocity would be the same.

4/18 | With neglect of hydraulic forces linear momentum is conserved & velocity $v_2 = v_1 = 1$ knot. Center of mass does not change position with respect to reference axes moving with constant speed of 1 knot.



Thus $(\Sigma m_i x_i)_1 = (\Sigma m_i x_i)_2$

$$\frac{1}{32.2}\left[120(2) + 180(8) + 160(16) + 300(s)\right]$$

$$= \frac{1}{32.2}\left[120(14+x) + 180(4+x) + 160(10+x) + 300(s+x)\right]$$

$$4240 = 4000 + 760x, \quad x = \frac{240}{760} = \underline{0.316 \text{ ft}}$$

Timing & sequence of changed positions does not affect final result because all forces are internal.

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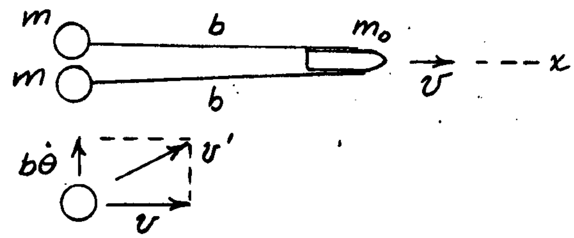

For system $\Delta G_x = 0$: $(m_o v + 2mv) - m_o v_o = 0$

$$v = \frac{m_o}{m_o + 2m} v_o$$

$U = \Delta T$: $0 = \frac{1}{2} m_o v^2 + 2\left[\frac{1}{2} m\,(v^2 + b^2\dot{\theta}^2)\right] - \frac{1}{2} m_o v_o^2$

$$(m_o + 2m)\,v^2 + 2mb^2\dot{\theta}^2 = m_o v_o^2$$

Substitute v & get $\dfrac{m_o^2 v_o^2}{m_o + 2m} + 2mb^2\dot{\theta}^2 = m_o v_o^2$

Solve for $\dot{\theta}$ & get $\quad \dot{\theta} = \dfrac{v_o}{b}\sqrt{\dfrac{m_o}{m_o + 2m}}$

5/5 | For $\theta = 90°$, $\underline{a} = -a_t \underline{i} - a_n \underset{\sim}{j}$ so $a_t = r\alpha = 1.8\ m/s^2$,

$$\alpha = \frac{1.8}{0.3} = \underline{6\ rad/s^2}$$

$$\&\ a_n = r\omega^2 = 4.8\ m/s^2,\ \omega = \sqrt{4.8/0.3} = \underline{4\ rad/s}$$

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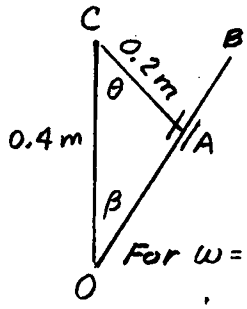
$$\tan\beta = \frac{0.2\sin\theta}{0.4-0.2\cos\theta}, \quad \tan\beta(2-\cos\theta) = \sin\theta$$



$$\dot\beta\sec^2\beta(2-\cos\theta) + \tan\beta(\dot\theta\sin\theta) = \dot\theta\cos\theta$$

$$\dot\beta = \frac{\cos\theta - \sin\theta\tan\beta}{2-\cos\theta}\dot\theta\cos^2\beta$$

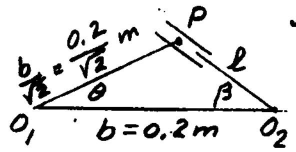
$$= \frac{2\cos\theta - 1}{(2-\cos\theta)^2}\dot\theta\cos^2\beta$$

For $\omega = -\dot\theta = 3\frac{\text{rad}}{\text{s}}$, $\theta = 45°$, $\beta = \tan^{-1}\frac{1/\sqrt2}{2-1/\sqrt2} = 28.7°$

$$\dot\beta = \frac{2/\sqrt2 - 1}{(2-1/\sqrt2)^2}(-3)\cos^2 28.7° = -0.572 \text{ rad/s}$$

So $\omega_{OB} = \underline{0.572 \text{ rad/s CCW}}$

▸5/83 | $\dfrac{b/\sqrt{2}}{\sin\beta} = \dfrac{b}{\sin(\pi-\theta-\beta)} = \dfrac{b}{\sin(\theta+\beta)}$



so $\sqrt{2}\sin\beta = \sin(\theta+\beta)$ - - - - - (a)

$\sqrt{2}\,\dot\beta\cos\beta = (\dot\theta+\dot\beta)\cos(\theta+\beta)$

$\omega_2 = -\dot\beta = \dot\theta\,\dfrac{\cos(\theta+\beta)}{\cos(\theta+\beta)-\sqrt{2}\cos\beta}$ - - - (b)

From (a) $\sin\beta(\sqrt{2}-\cos\theta) = \sin\theta\cos\beta$, $\tan\beta = \dfrac{\sin\theta}{\sqrt{2}-\cos\theta}$

For $\theta = 20°$, $\beta = \tan^{-1}\dfrac{0.3420}{\sqrt{2}-0.9397} = \tan^{-1}0.7208 = 35.8°$

& for $\dot\theta = -2$ rad/s, Eq. (b) gives

$$\omega_2 = -2\,\frac{\cos(20°+35.8°)}{\cos(20°+35.8°)-\sqrt{2}\cos 35.8°} = -2\,\frac{0.5623}{-0.5849}$$

$\underline{\omega_2 = 1.923 \text{ rad/s}}$