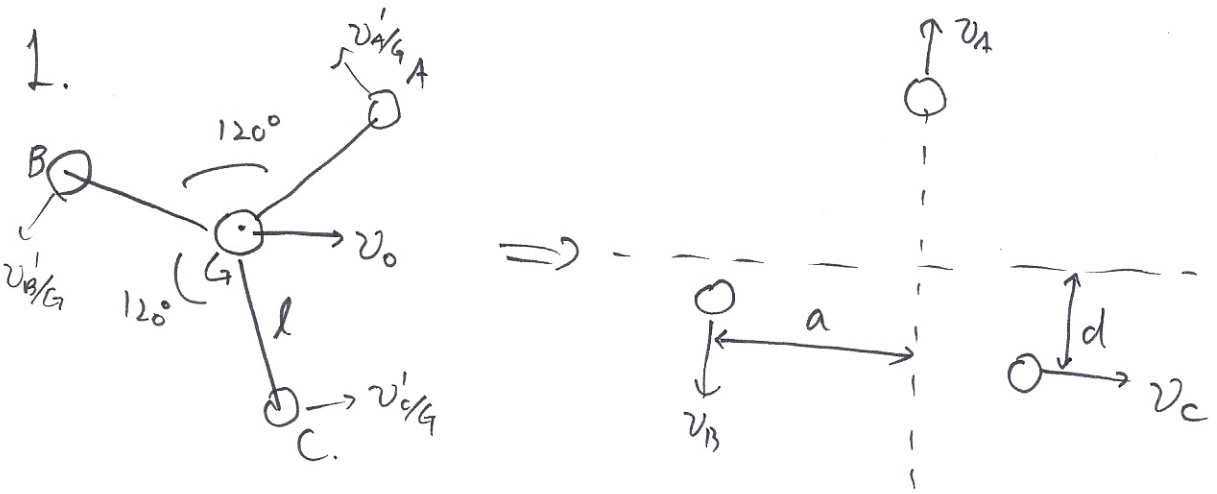
1.



$v_0 = v_0 \hat{i}$ m/s.

$v_A = 2.6\hat{j}$ m/s $\quad v_C = 4.5\hat{i}$ m/s.

$a = 260$ mm $\quad d = 150$ mm.

(a) conservation of linear momentum

$$m(\overline{v}'_{A/G} + \overline{v}_0) + m(\overline{v}'_{B/G} + \overline{v}_0) + m(\overline{v}'_{C/G} + \overline{v}_0) = m\overline{v}_A + m\overline{v}_B + m\overline{v}_C$$

$$m(\underbrace{\overline{v}'_{A/G} + \overline{v}'_{B/G} + \overline{v}'_{C/G}}_{\substack{\| \\ 0}} + 3v_0) = mv_A + mv_B + mv_C$$

0 (same center rotation)
(same angle (120°))

$$3\cancel{m}v_0\hat{i} = \cancel{m}v_A\hat{j} - \cancel{m}v_B\hat{j} + \cancel{m}v_C\hat{i}$$
$$= (v_A - v_B)\hat{j} + v_C\hat{i}$$

$v_A - v_B = 0 \qquad v_B = v_A = \underline{2.6}$

$v_C = 3v_0 \qquad v_0 = \frac{1}{3}v_C = \underline{1.5}$ //

$\underline{v_0 = 1.5\hat{i} \text{ m/s}}$ //

(b) conservation of angular momentum.

$$3ml^2\omega\hat{k} = mav_B\hat{k} + mdv_C\hat{k} = m(0.26 \cdot 2.6 + (0.15) \cdot (4.5))$$

$$l^2\omega = \underline{0.45033 \text{ m}^2/\text{s}}$$

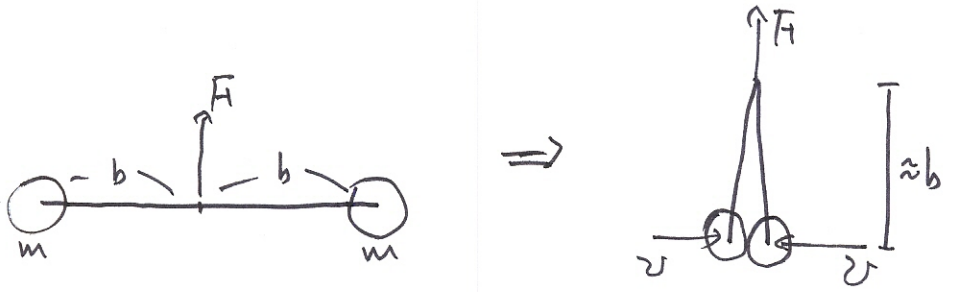
$$\begin{cases} v'_{A/G} = v_A - v_O = 2.6j - 1.5i \\ v'_{B/G} = v_B - v_O = -2.6j - 1.5i \\ v'_{C/G} = v_C - v_O = 4.5i - 1.5i \end{cases}$$

$$|v'_{A/G}| = l\omega = |2.6j - 1.5i| = 3\,m/s.$$

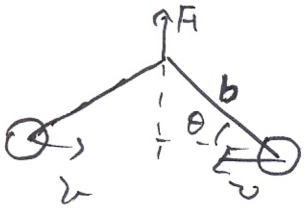
$$\therefore\ l = \frac{l^2\omega}{l\omega} = \frac{0.45033}{3} = \underline{\underline{0.1501\,m.}}$$

(c) $$\omega = \frac{l\omega}{l} = \frac{3}{0.1501} = \underline{\underline{19.99\,rad/s}}$$

2.



∘ Energy conserve. (input = output)



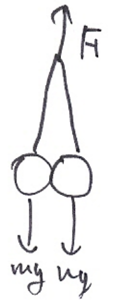
$$\Delta U = \Delta T$$

$$F b \sin\theta = \frac{1}{2}(2m)v^2$$

$$v = \sqrt{\frac{Fb}{m}\sin\theta}$$

$$v_{\theta=90} = \sqrt{\frac{Fb}{m}}$$

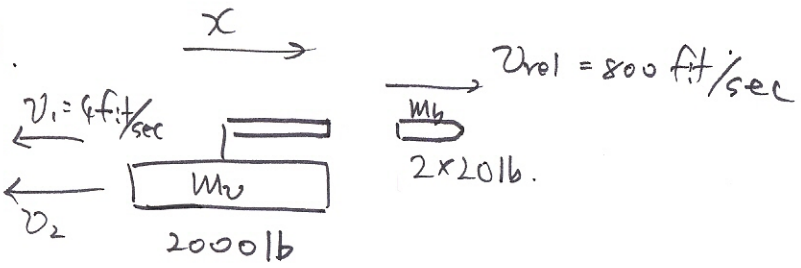
∘ $T_{max} < 2mg$ ($\because$ ball do not lose contact)



$= \quad a_{cm} = 0 \quad \therefore F - 2mg = 0$

$F = 2mg$

3.



linear momentum conserve (x-directn.)

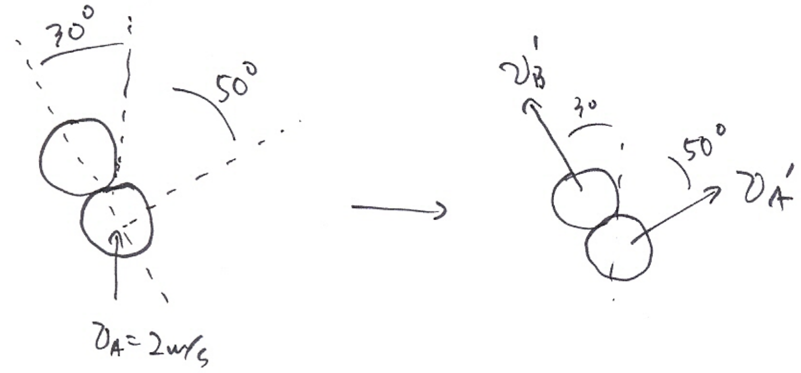
$$(m_2+m_b)v_1 = m_2 v_2 + m_b(v_{rel}+v_2)$$

$$\frac{1}{\cancel{g}}(2000+40)(-4) = \frac{1}{\cancel{g}}(2000(-v_2)+40(800-v_2))$$

$$2040\,v_2 = 32000+8160$$

$$\underline{\underline{v_2 = 19.69 \text{ fit/sec.}}}$$

4.



$\Sigma F_x = \Sigma F_y = 0$

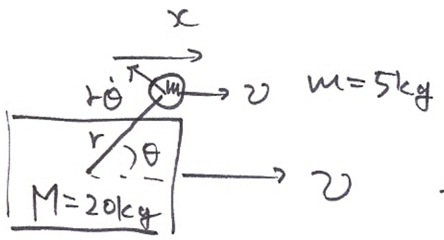
linear momentum conserve.

$\rightarrow x$ $\quad 0 = -m v_B' \sin 30 + m v_A \sin 50 \quad \cdots ①$

$\uparrow y$ $\quad m \cdot 2 = m v_B \cos 30 + m v_A \cos 50 \quad \cdots ②$

①.② $\rightarrow$ $v_A = 1.015$ m/s $\quad v_B = 1.556$ m/s

5.



→ free rolls $\Sigma F_x = 0$.

$\dot\theta = 4$ rad/s. $r = 0.4$m.

linear momentum conserve (x-direction)

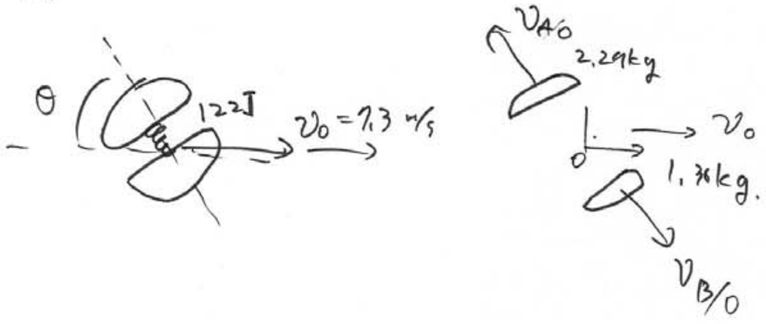
$\theta = 0$ $\theta = 60$

$$(M+m)v_1 = Mv_2 + m(v - (r\cdot\dot\theta)\sin 60)$$

$$(25)(0.6) = 20\cdot v_2 + 5(0.6 - 1.6\sin 60)$$

$$\underline{v_2 = 0.877 \text{ m/s}}$$

6.



momentum conserve.

$$(m_A + m_B)v_0 = m_A(v_{A/0} + v_0) + m_B(v_{B/0} + v_0)$$

$$v_{B/0} = -\frac{m_A}{m_B} v_{A/0}$$

$$= -\frac{2.27}{1.36} v_{A/0} \quad \cdots \text{①}$$

energy conserve.

in moving frame. ($\rightarrow v_0 = 7.3$)

$$122 = \frac{1}{2} m_A v_{A/0}^2 + \frac{1}{2} m_B v_{B/0}^2 \quad \cdots \text{②}$$

①, ② $\left(\frac{2.27}{2} + \frac{1.36}{2}\left(\frac{2.27}{1.36}\right)^2\right) v_{A/0}^2 = 122$

$$v_{A/0} = .6.346 \text{ m/s}$$

$$|v_A| = \left(\left(-v_{A/0}\cos\theta + v_0\right)^2 + \left(v_{A/0}\sin\theta\right)^2\right)^{1/2}$$

$$|v_B| = \left(\left(v_{B/0}\cos\theta + v_0\right)^2 + \left(-v_{B/0}\sin\theta\right)^2\right)^{1/2}.$$

Source code

```
theta=(30/180)*pi:0.01:(120/180)*pi;
ang=theta*180/pi;

va = (122/(2.27/2 + 2.27^2/(2*1.36)))^(1/2);
vb = (va*2.27)/1.36;

Va = ((-va.*cos(theta)+7.3).^2 + (va.*sin(theta)).^2).^(1/2);
Vb = ((vb.*cos(theta)+7.3).^2 + (-vb.*sin(theta)).^2).^(1/2);
V(:,1) =Va;
V(:,2) =Vb;

plot(ang,V);
```