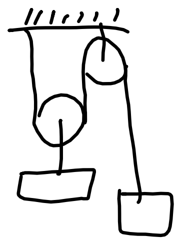
February 21, 2017



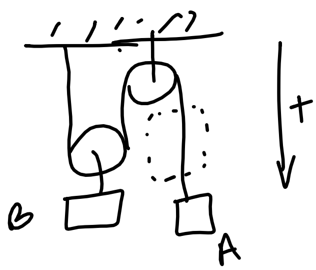
m_B $m_A = 2\,kg$

→ find a_x of A & B after releasing.

Assumptions

- Massless pulleys: needn't account for lifting weight of pulleys.

- Massless rope: Allows to assume uniform tension



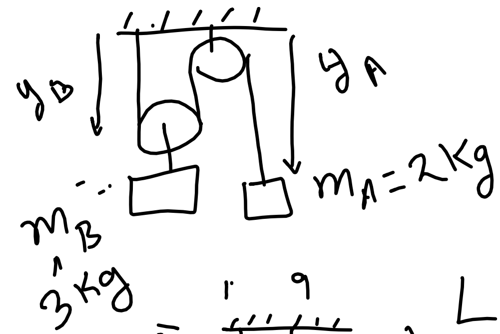
$T_1 - T_2 = m_r a_r$

$T_1 = T_2$ if $m_r = 0$.

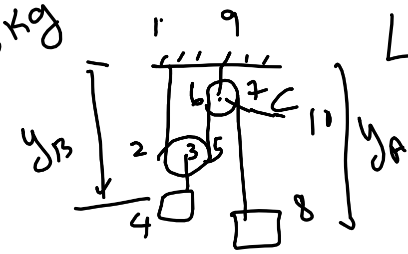
- Pulleys are frictionless:

$T_1 - T_2 - \overset{0}{\cancel{\int f\,dr}} = \overset{0}{\cancel{m_r}} a_r$

$T_1 = T_2$



$$2y_B + y_A + \text{Constants} = L$$



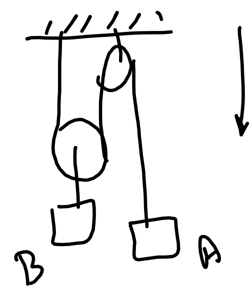
$$L = L_{12} + P_{Ar} + L_{56} + P_{Cr} + L_{78}$$

$$= (y_B - L_{34}) + P_{Br} + (y_B - L_{9,10} - L_{34}) + P_{Cr} + y_A - L_{9,10}$$

$$L = 2y_B + y_A + \text{Constants}$$

$$\Rightarrow 0 = \dot{L} = 2V_B + V_A$$

$$\Rightarrow \underbrace{0 = 2a_B + a_A}$$

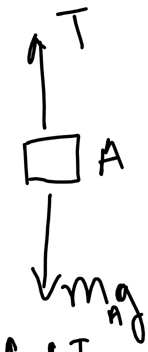


$$2a_B + a_A = 0 \quad (1)$$

$+\downarrow$

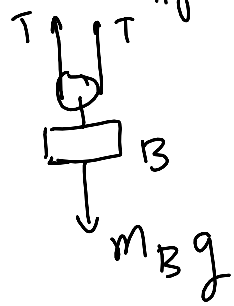
$$\Sigma F_y = m a_y$$

$$\Rightarrow m_A g - T = m_A a_A \quad (2)$$



$$\Sigma F_y = m a_y$$

$$\Rightarrow m_B g - 2T = m_B a_B \quad (3)$$



from (1) $a_A = -2a_B$.

subs in (2), $2m_A g - \cancel{2T} = 2m_A a_A = -4m_A a_B$

(3) $\rightarrow$ $m_B g - \cancel{2T} = m_B a_B$

$$\underline{\quad - \qquad + \qquad - \quad}$$

$$(2m_A - m_B)g = -(4m_A + m_B)a_B$$

$$a_B = \left(\frac{m_B - 2m_A}{4m_A + m_B}\right)g$$

for B to go up, $a_B \leq 0$

$$\rightarrow g\left(\frac{m_B - 2m_A}{4m_A + m_B}\right) \leq 0 \Rightarrow \underline{m_B \leq 2m_A}$$

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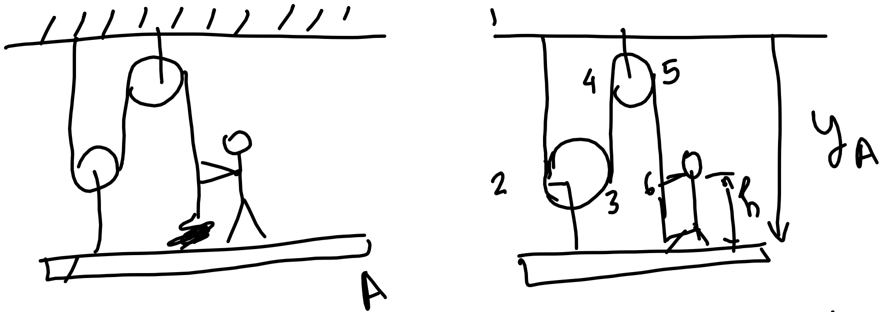


$$L = L_{12} + L_{23} + L_{34} + L_{45} + L_{56}$$

$$= y_A - d_p + L_{23} + y_A - d_p - d_{p_1}$$

$$+ L_{45} + y_A - h - d_{p_1}$$

$$L = 3y_A + \text{constants}$$

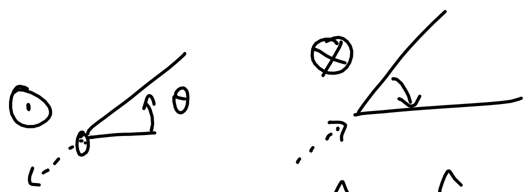
$$\dot{L} = 3 v_A$$

$$\ddot{L} = 3 a_A$$

Assumptions for using simplified polar equations of acceleration.

1) $\hat{u}_r$ is pointed from origin to particle.

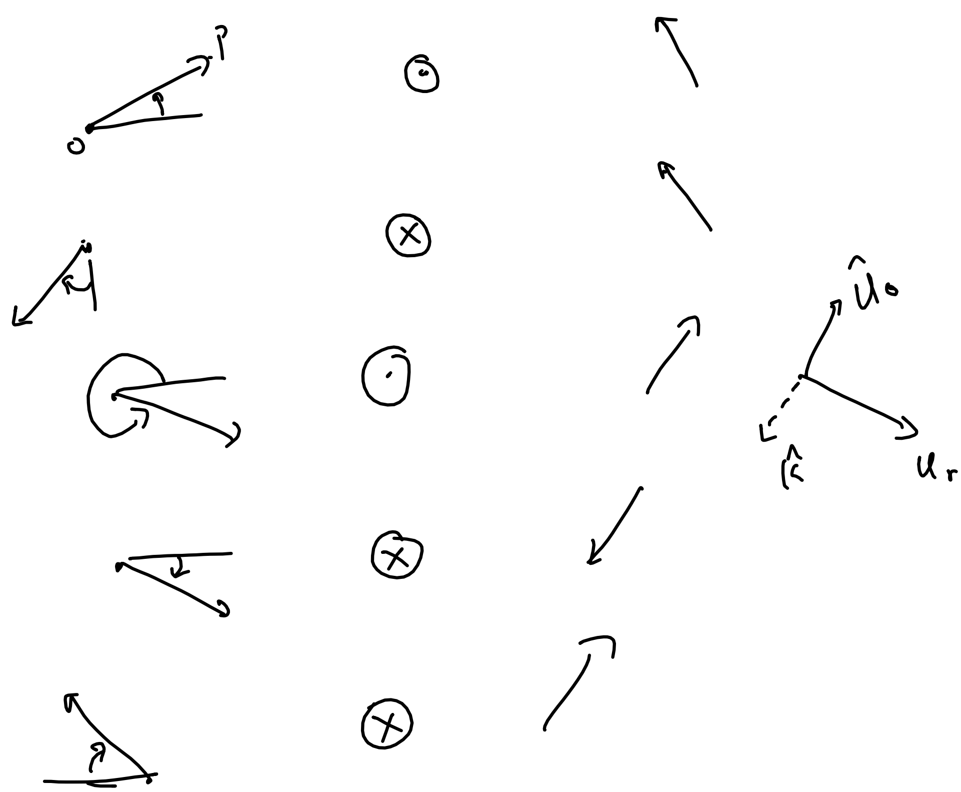
2) $\hat{k}$ is along the direction of $\dot{\theta}$.



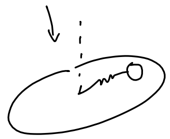
3) $\hat{u}_\theta$ is $\hat{k} \times \hat{u}_r$

$$\vec{a} = (\ddot{r} - r\omega^2)\hat{u}_r + (\alpha r + 2\dot{r}\omega)\hat{u}_\theta$$

$\hat{k}$ $\hat{u}_\theta$



3.87



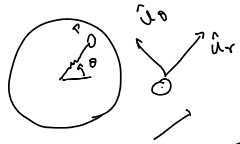
$m = 3\ lb$

$l_0 = 0.75\ ft$

$d_{max} = 1.85\ ft$

$V_0 = 20\ ft/s$

$K = ?$ so that min distance $= \frac{d_{max}}{2}$



$\vec{a} = (\ddot{r} - r\omega^2)\hat{u}_r + (r\alpha + 2\dot{r}\omega)\hat{u}_\theta$

$K(r - l_0)$

$\Sigma F_r = m a_r$

$\Rightarrow -K(r - l_0) = m(\ddot{r} - r\omega^2) \quad -①$

$\Sigma F_\theta = m a_\theta$

$0 = m(r\alpha + 2\dot{r}\omega)$

$\Rightarrow r\alpha + 2\dot{r}\omega = 0$

$\Rightarrow r^2 \frac{d\omega}{dt} + 2r\frac{dr}{dt}\omega = 0$

$\Rightarrow r^2 \frac{d\omega}{dt} + \frac{dr^2}{dt}\omega = 0$

$\Rightarrow \frac{d}{dt}(r^2\omega) = 0$

$\Rightarrow r^2\omega =$ constant

$r^2\omega = d_{max}^2\left(\frac{V_0}{d_{max}}\right)$

$\vec{\dot{r}} = \dot{r}\hat{u}_r + r\omega\hat{u}_\theta$

at d_{max}, $\dot{r} = 0$,

$\vec{\dot{r}} = d_{max}\omega_{max}\hat{u}_\theta = V_0\hat{u}_\theta$

$\Rightarrow \omega_{max} = \frac{V_0}{d_{max}}$

$r^2\omega = d_{max}V_0$

$-K(r - l_0) = m(\ddot{r} - r\omega^2)$

$-K(r - l_0) = m\left(\ddot{r} - \frac{d_{max}^2 V_0^2}{r^3}\right)$

$\ddot{r}$

$\dot{r}\frac{d\dot{r}}{dr} \qquad \frac{d\dot{r}}{dt} \qquad \frac{d^2r}{dt}$