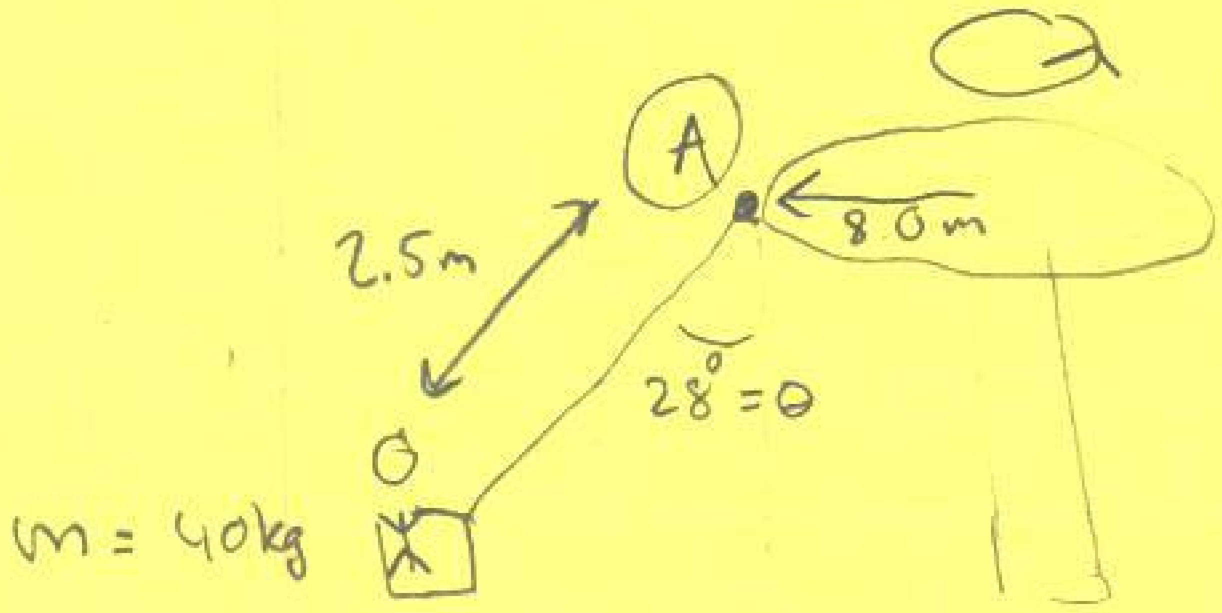
Practice - E conservation - Rotational Motion

Practice Problem PSE 63



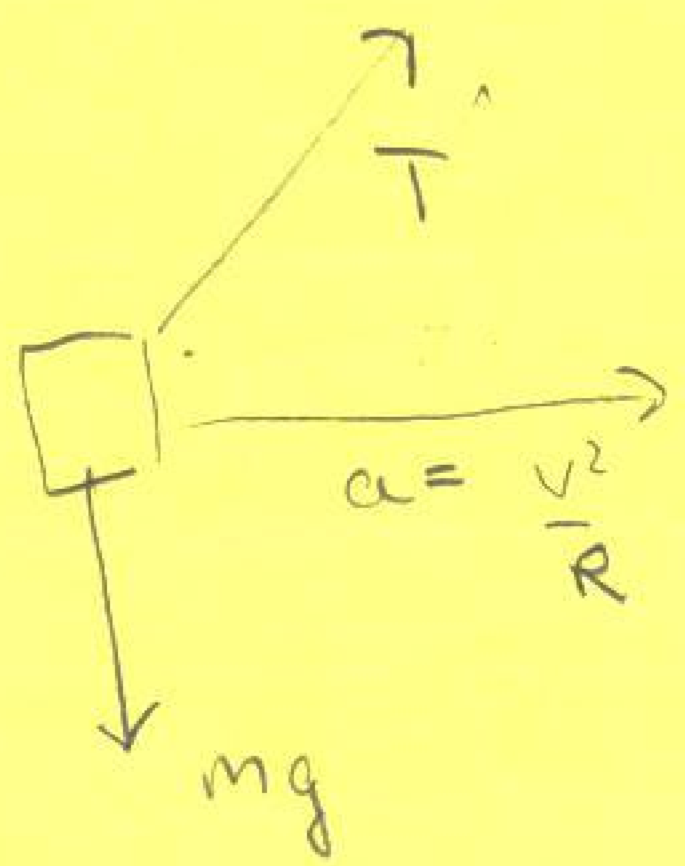
① Find the speed of each child

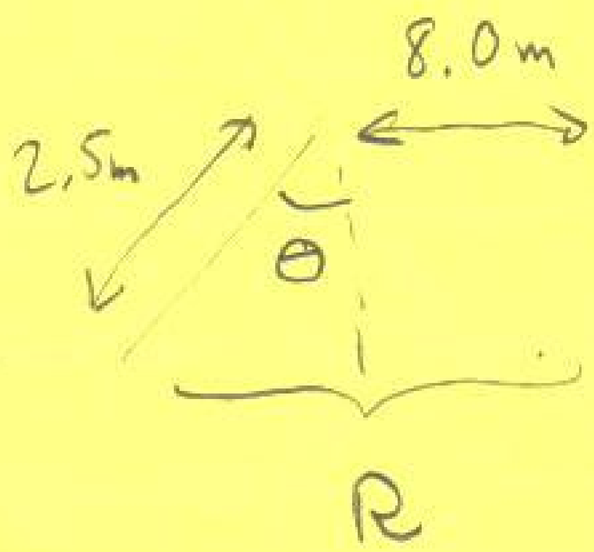
② Find the speed at point A

③ Find the angular velocity ω

④ Find the tension in the rope

Solution:





$R = 8.0m + 2.5m \sin 28°$

$R = 9.17\,m$

$\sum F^x = ma^x$ $\qquad$ $\sum F^y = ma^y$

$T \sin\theta = m\frac{v^2}{R}$ $\qquad$ $T\cos\theta - mg = m\cancelto{0}{a^y}$

$\frac{mg}{\cos\theta}\sin\theta = m\frac{v^2}{R}$ $\qquad$ $T = \frac{mg}{\cos\theta}$

$gR\tan\theta = v^2$ $\qquad$ (4) $\rightarrow$ $T = 443\ N$

$\sqrt{gR\tan\theta} = V$

(1) $v = 6.9125\ m/s$

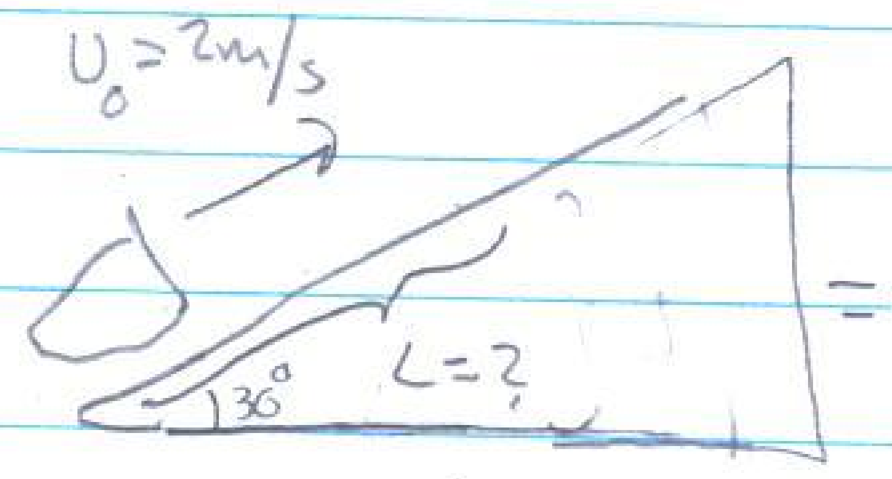
(3) $\omega = \frac{\Delta\theta}{\Delta t}$ = angular velocity

$R\omega = R\frac{\Delta\theta}{\Delta t} = \frac{\Delta s}{\Delta t} = V$ $\qquad$ $\omega = 0.7538\ rad/s$

(2) $V_A = \omega \cdot R_A = 0.7538\ rad/s \cdot 8.0\ m = 6.034\ m/s$

Practice Energy #2 Easy

$m_1 = 2kg$



$$W_e = \Delta KE + \Delta PE$$

$$\cancel{W_e} = \cancel{KE_f} - KE_i + PE_f - \cancel{PE_i}$$

$$0 = -\frac{1}{2}mv^2 + mgh$$

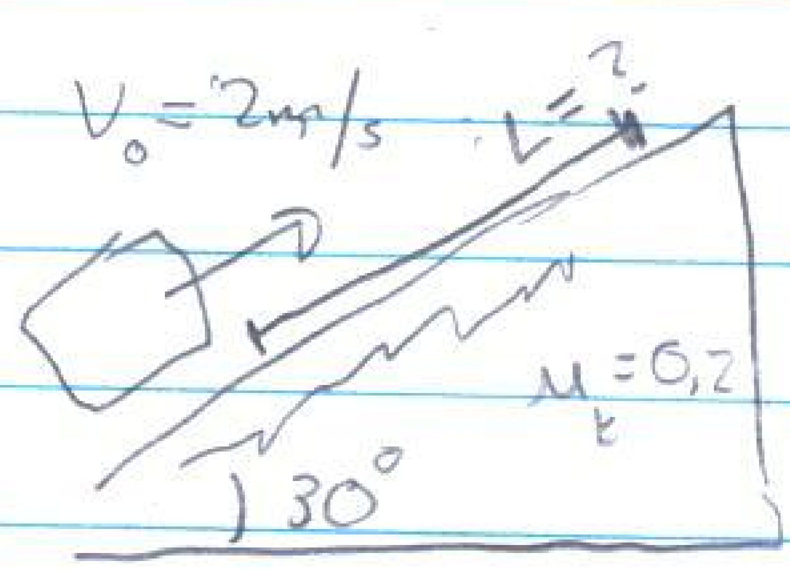
$$\frac{1}{2}\cancel{m}v^2 = \cancel{m}gh$$

$$\frac{1}{2}v^2 = g\,L\sin\theta$$

$$\frac{v^2}{2g\sin\theta} = L \qquad L = 0.4m$$

Practice Energy #3 ~~A~~Medium

$m = 2kg$



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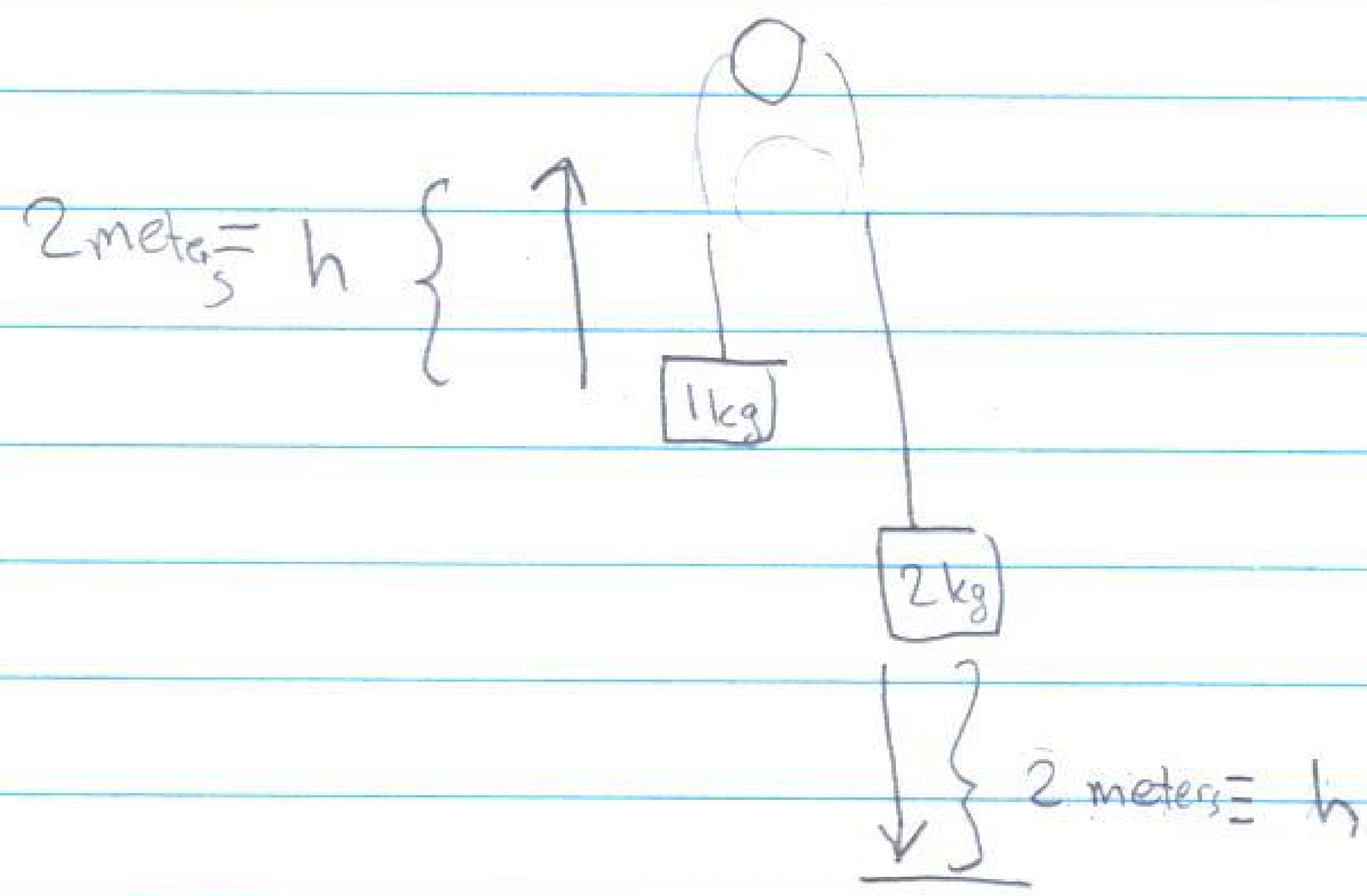
Practice Energy:



Use Energy to find speed when hits the ground:

$$\cancel{W_{ext}} = \Delta PE + \Delta KE$$

$$0 = \Delta PE_1 + \Delta PE_2 + \Delta KE_1 + \Delta KE_2$$

$$\Delta PE_1 = m_1 g \Delta h = m_1 g h \qquad \Delta KE_1 = \frac{1}{2} m_1 v^2$$

$$\Delta PE_2 = -m_2 g h = -m_2 g h \qquad \Delta KE_2 = \frac{1}{2} m_2 v_2^2$$

$$0 = m_1 g h - m_2 g h + \frac{1}{2} m_1 v^2 + \frac{1}{2} m_2 v^2$$

$$2gh \frac{(m_2 - m_1)}{m_2 + m_1} = v^2$$

$$\boxed{V = 3.65}$$

$$\sqrt{2gh} \left(\frac{m_2 - m_1}{m_2 + m_1} \right)^{1/2} = V \nearrow \qquad \left(\frac{m_2 - m_1}{m_2 + m_1} \right)^{1/2} = \left(\frac{2-1}{2+1} \right)^{1/2} = \frac{1}{\sqrt{3}}$$

Lab Problem:

a) A 200N/m spring is compressed 5cm

find the Potential Energy stored in the spring

Solution $W = \frac{1}{2} k x^2$

$$W = \frac{1}{2} (200 \tfrac{N}{m}) (.05m)^2$$

$$W = 0.25 J$$

b) Two 500 gram carts are pushed apart by this Spring find V_1

Before 

$v_1 = ?$

After  v_2

Solution on next page V:

$$v = \sqrt{\frac{2W}{m_1(1 + m_1/m_2)}} = \sqrt{\frac{2(0.25J)}{0.5kg\left(1 + \frac{0.5kg}{0.5kg}\right)}} = 0.707 m/s$$

spring is compressed and has $PE = W$

Solution Before After

Momentum Conservation: $0 = m_1 v_1 + m_2 v_2$

$$v_2 = -\frac{m_1}{m_2} v_1$$

E conservation:

$$\cancel{W_{ext}} = \Delta PE + \Delta KE$$

$$= \cancel{PE_F}^{\,0} - PE_i + KE_f - \cancel{KE_i}^{\,0}$$

$$PE_i = KE_f$$

$$W = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

$$W = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 \left(\frac{-m_1}{m_2} v_1 \right)^2$$

$$W = \frac{1}{2} \left(m_1 + \frac{m_1^2}{m_2} \right) v_1^2$$

$$\frac{2W}{m_1 \left(1 + \frac{m_1}{m_2}\right)} = v_1^2 \implies v_1 = \sqrt{\frac{2W}{m_1\left(1 + \frac{m_1}{m_2}\right)}}$$

See previous page for numbers

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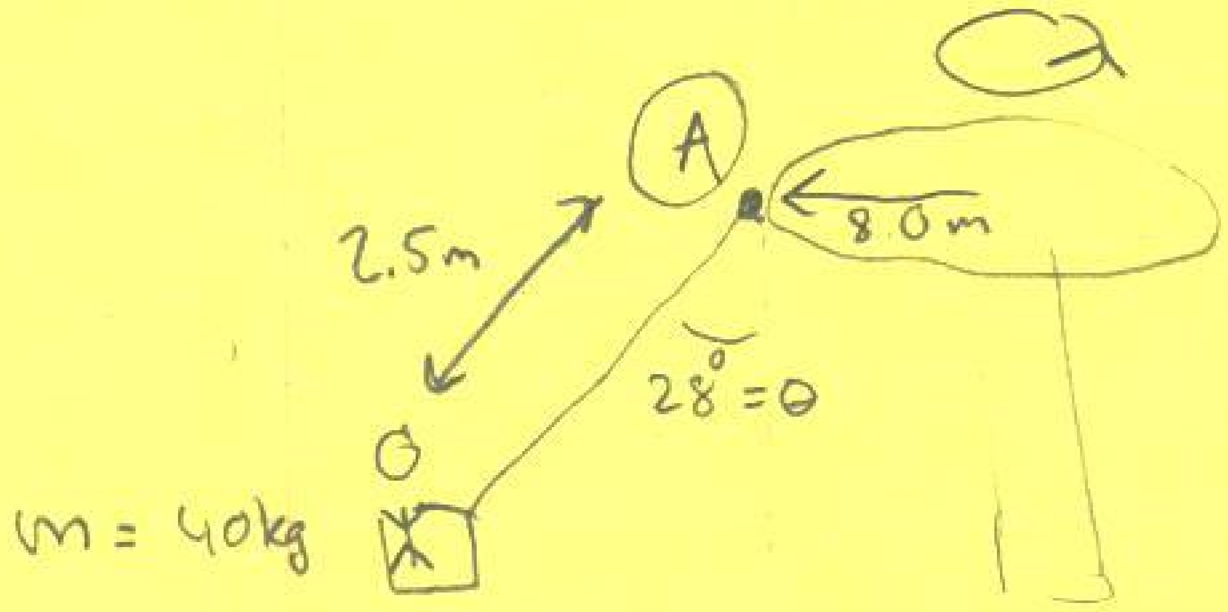

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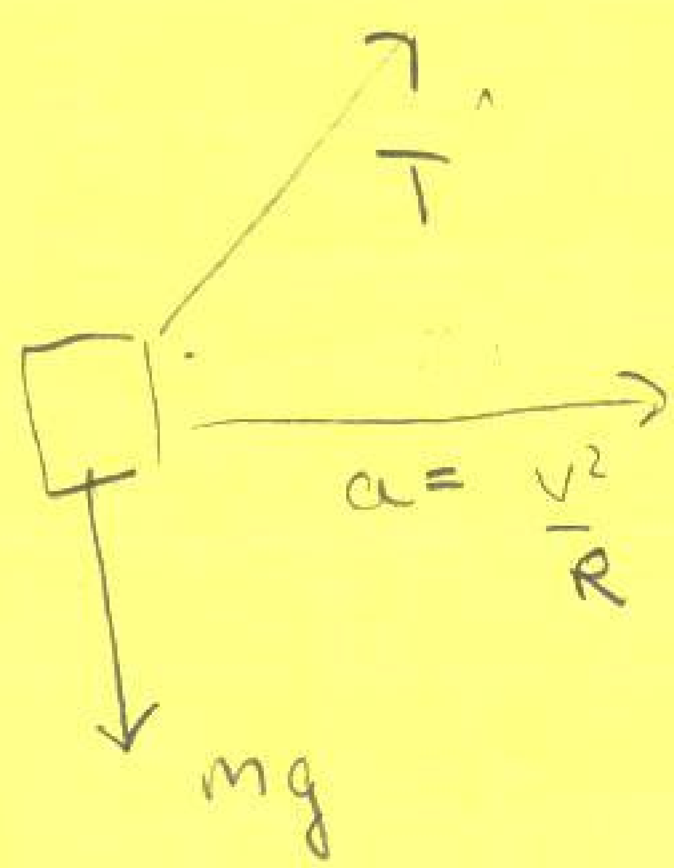

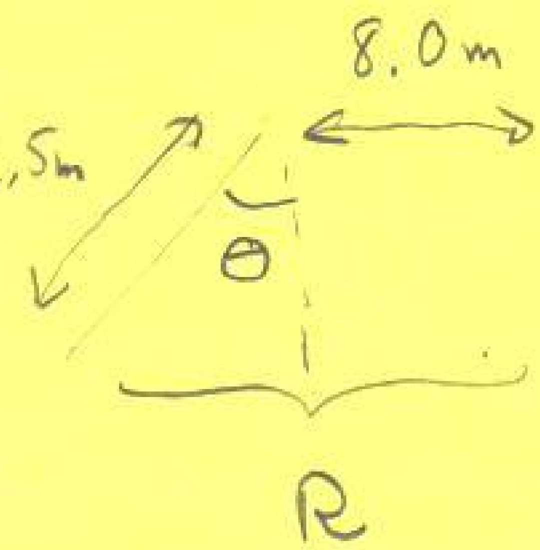

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