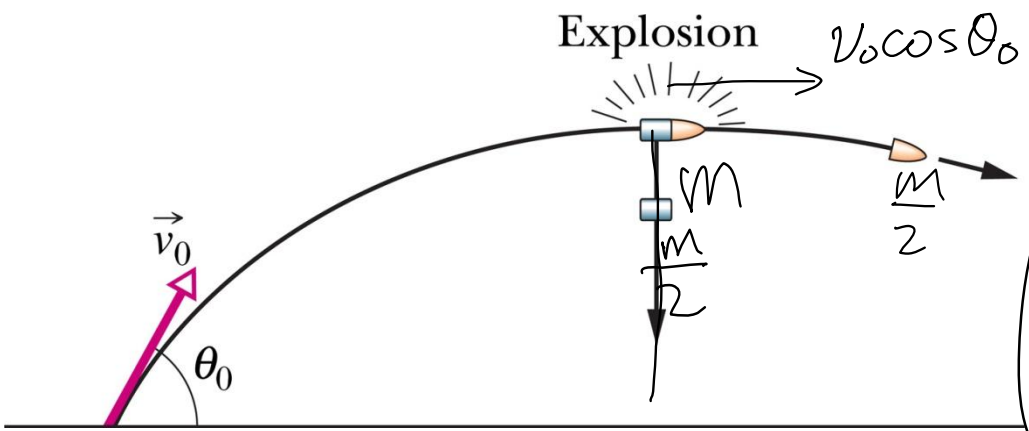
Copyright statement

- The images and the pictures in this lecture are provided by the CDs accompanied by the books
  1. University Physics, Bauer and Westfall, McGraw-Hill, 2011.
  2. Principles of Physics, Halliday, Resnick, and Walker, Wiley, 8^{th} and 9^{th} Ed.
- The rest is made by me.

Problem 1



$$y = v_0\sin\theta_0 t - \frac{1}{2}gt^2$$

$$x = v_0\cos\theta_0 t$$

$$v_y = v_0\sin\theta_0 - gt = 0$$

$$t = \frac{v_0\sin\theta_0}{g}$$

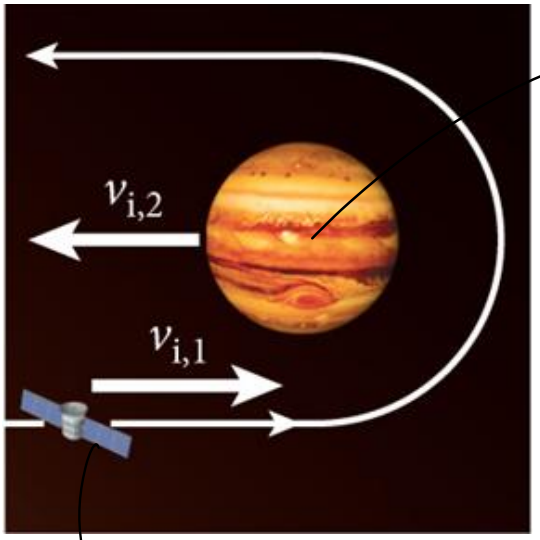
$$\frac{v_0^2}{g}\sin\theta_0\cos\theta_0$$

$$h = \frac{v_0^2\sin^2\theta_0}{g} - \frac{1}{2}g\frac{v_0^2\sin^2\theta_0}{g^2} = \frac{v_0^2\sin^2\theta}{2g}$$

$$mv_0\cos\theta_0 = \frac{m}{2}V \qquad V = 2v_0\cos\theta_0$$

$$L = \frac{v_0^2}{g}\sin\theta_0\cos\theta_0 + 2v_0^2\cos\theta_0\frac{\sin\theta_0}{g} = \frac{3v_0^2\sin\theta_0\cos\theta_0}{g}$$

Problem 2: slingshot maneuver



v_{1f}

v_{2i}

m_2

m_1

$m_2 >> m_1$

Elastic collision

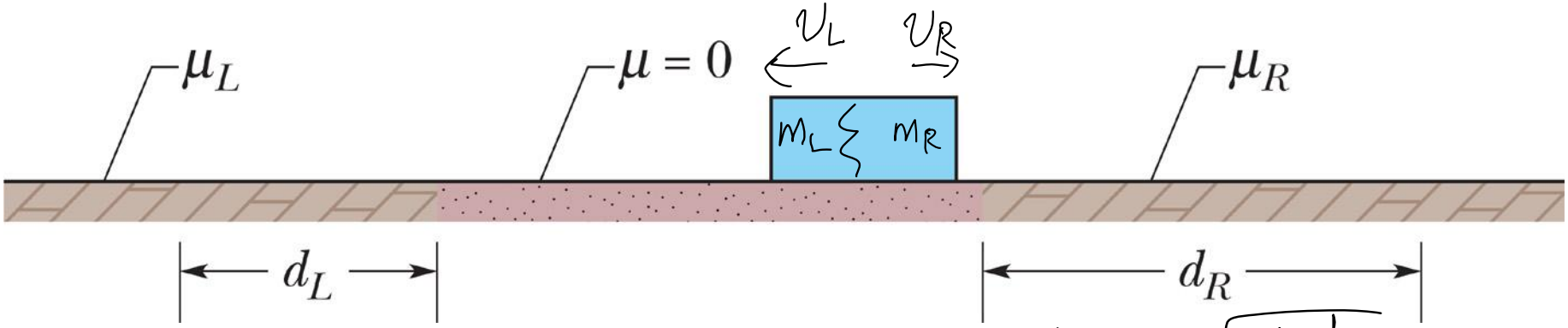
$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$$

$$v_{1f} = \underbrace{\frac{m_1 - m_2}{m_1 + m_2}}_{\simeq -1} v_{1i} + \underbrace{\frac{2m_2}{m_1 + m_2}}_{\simeq 2} v_{2i}$$

$$\simeq -v_{1i} + 2v_{2i}$$

Problem 3



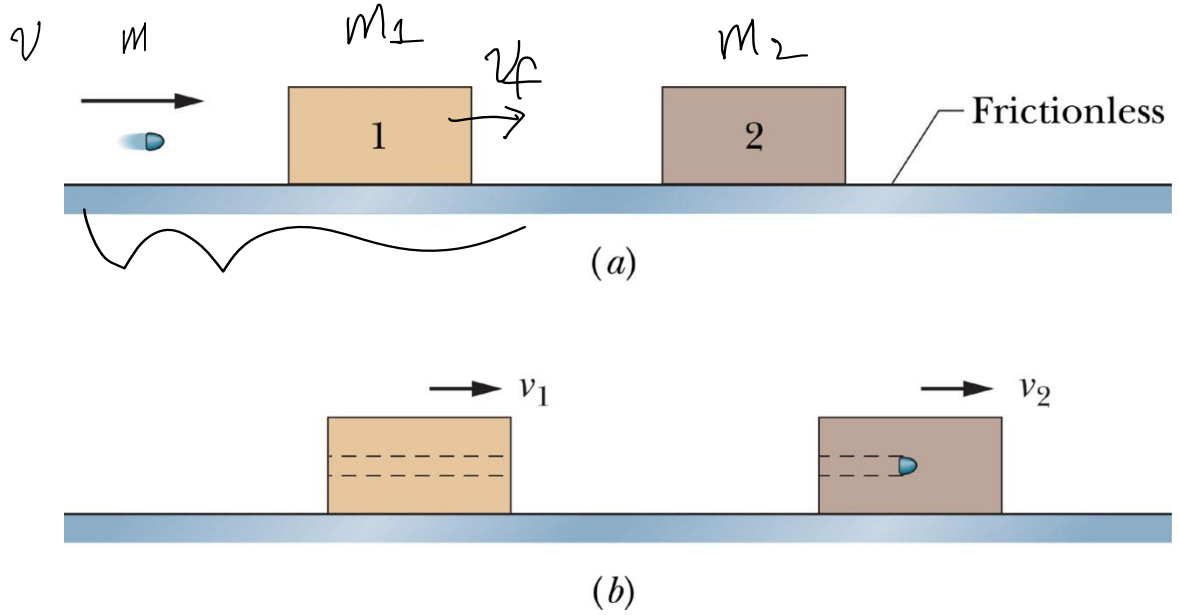
$$0 = m_L v_L + m_R v_R \rightarrow -\frac{v_L}{v_R} = \frac{m_R}{m_L} = \sqrt{\frac{\mu_L d_L}{\mu_R d_R}}$$

$$\frac{1}{2} m_L v_L^2 = \mu_L m_L g d_L \qquad \frac{1}{2} m_R v_R^2 = \mu_R m_R g d_R$$

$$v_L^2 = 2 g d_L \mu_L \qquad v_R^2 = 2 g \mu_R d_R$$

$$m_L : m_R = \sqrt{\mu_R d_R} : \sqrt{\mu_L d_L}$$

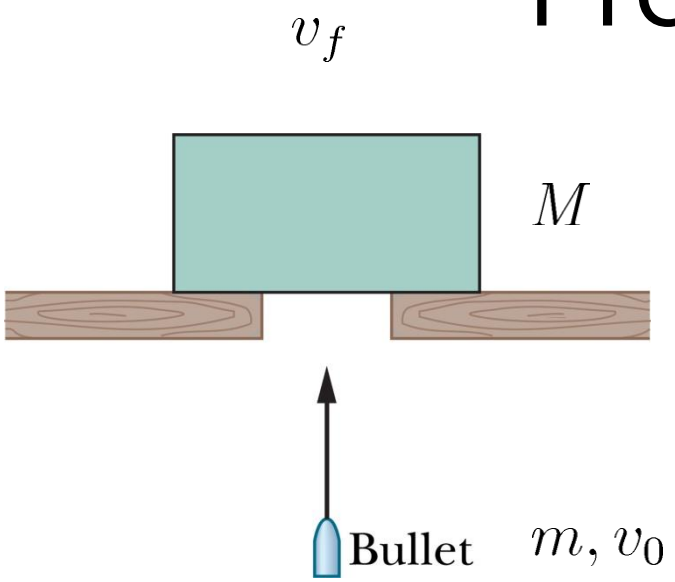
Problem 4



$$mv = mv_f + m_1 v_1 = (m + m_2)\, v_2 + m_1 v_1$$

$$mv_f = (m_2 + m)\, v_2$$

Problem 5

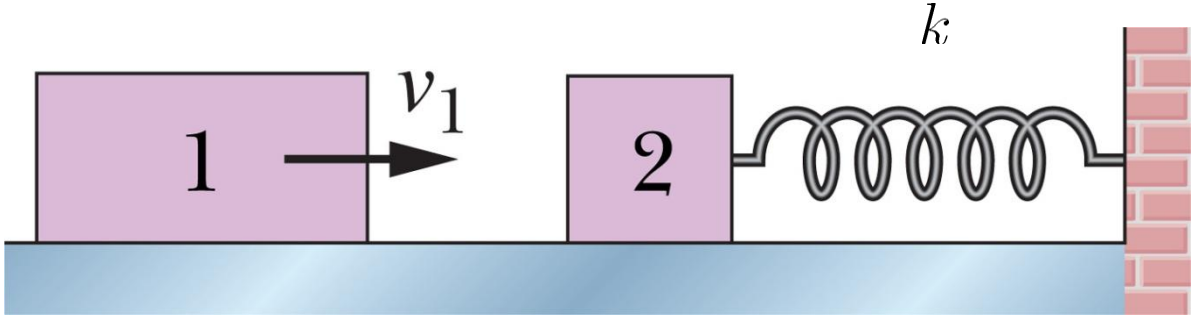


$$mv_0 = mv_f + MV$$

$$V = \frac{m}{M}(v_0 - v_f)$$

$$0^2 - V^2 = -2gh \qquad h = \frac{1}{2g}\frac{m^2}{M^2}(v_0 - v_f)^2$$

Problem 6



$d = ?$

$m_1 v_1 = (m_1 + m_2) V$

$V = \frac{m_1 v_1}{m_1 + m_2}$

$\frac{1}{2}(m_1 + m_2) V^2 = \frac{1}{2} k d^2$

$d^2 = \frac{m_1 + m_2}{k} \frac{m_1^2 v_1^2}{(m_1 + m_2)^2} = \frac{m_1^2 v_1^2}{k(m_1 + m_2)}$

$d = \frac{m_1 v_1}{\sqrt{k(m_1 + m_2)}}$

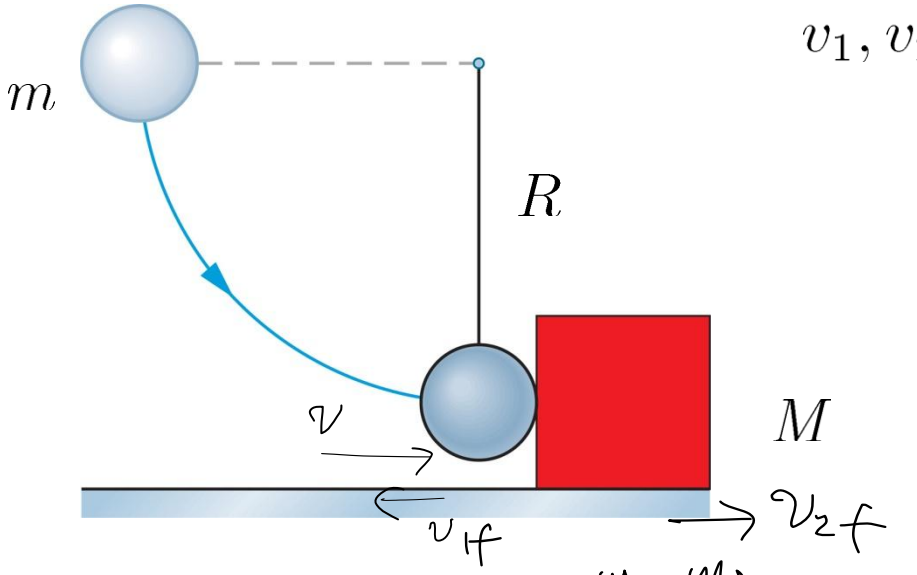
$\frac{ma}{x} \quad \frac{mv^2}{m^2 v^2}$

$\frac{m^2 v^2}{s^2}$

$\frac{mv^2}{F/x} = \frac{mx^2}{ma}$

$\frac{xv^2}{a} \Rightarrow \frac{L(L/T)^2}{L T^{-2}}$

Problem 7



$v_1, v_2 = ?$

$$mgR = \frac{1}{2}mv^2$$

$$v = \sqrt{2gR}$$

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v$$

$$v_{2f} = \frac{2m_1}{m_1 + m_2} v$$

$$v_1 = \frac{m - M}{m + M}\sqrt{2gR}$$

$$v_2 = \frac{2m}{m + M}\sqrt{2gR}$$

$2m \cdot 2gh = mgH$ $H = 4h$ $\frac{1}{2}m(2v)^2 = mgH$

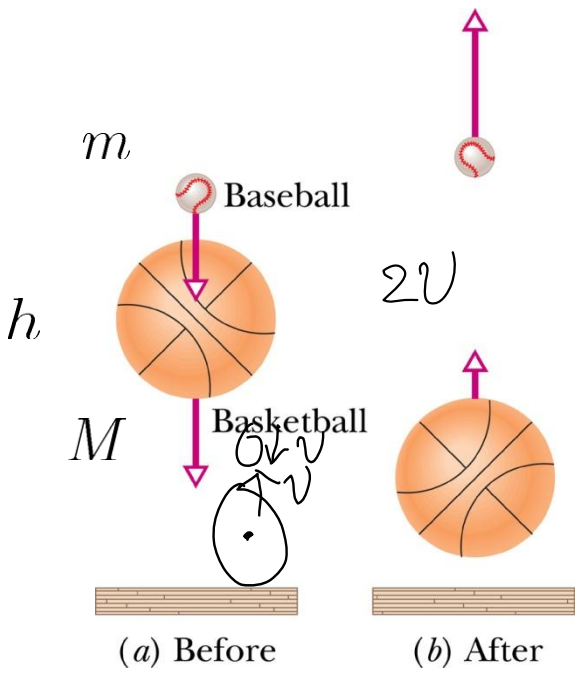
$\frac{9}{2}m\,2gh = mgH$

Problem 8

$mgh = \frac{1}{2}mv^2$ $H = 9h$

$v = \sqrt{2gh}$

$r, R \ll h$



$v_{0f} = \frac{m-M}{m+M}(v) + \frac{2M}{m+M}v$

$v_{0} \simeq \frac{2m}{m+M}(-v) + \frac{-m+M}{m+M}v$

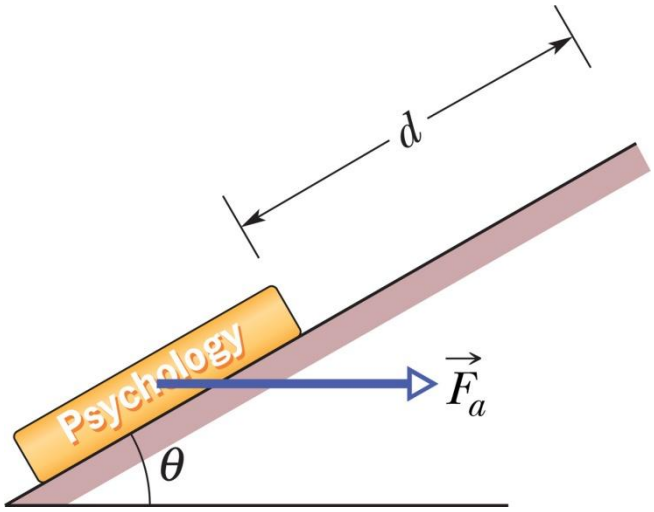
$v_{0f} = \frac{v}{m+M}(3M-m)$

$v_{bf} = \frac{v}{m+M}(M-3m)$

$M \gg m$

$M = 3m$

5장: 책 밀어올리기



최저점에서, 최고점에서의 속도

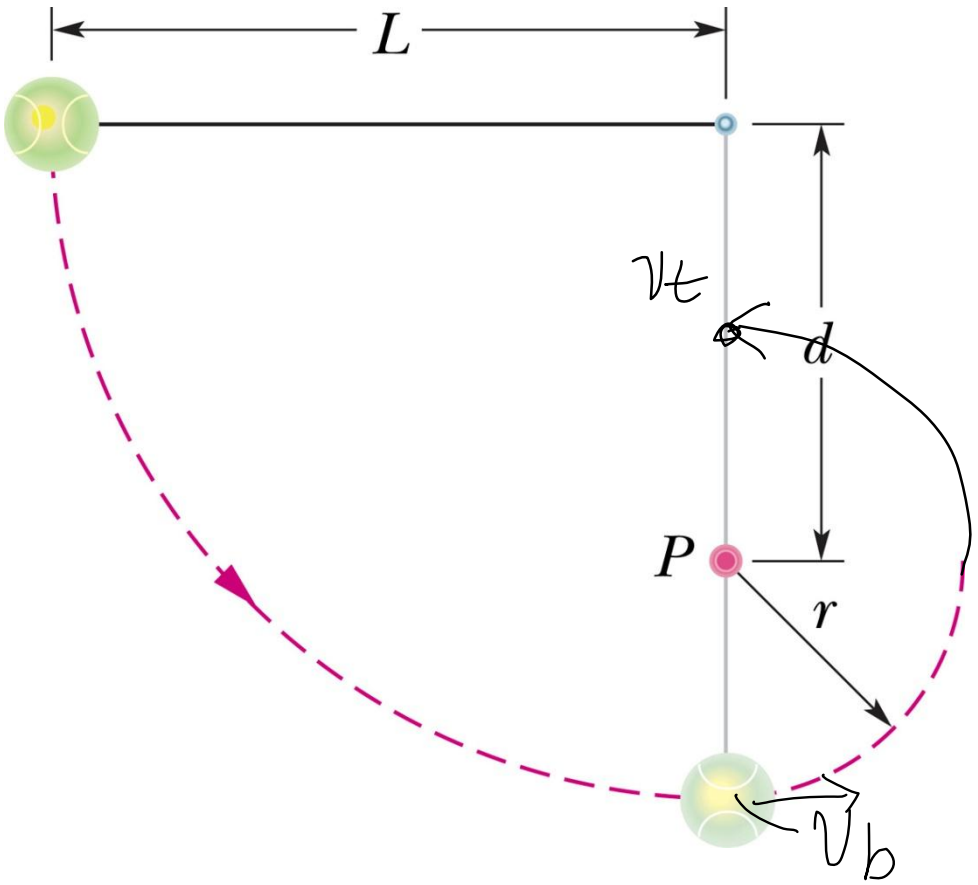
$$v_b = \sqrt{2gL}$$

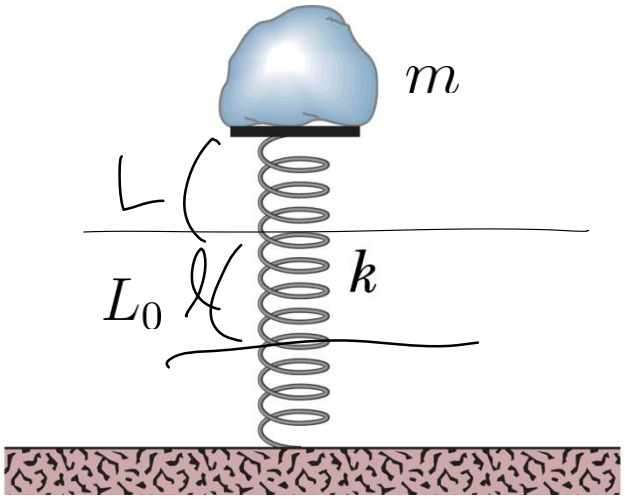
$$mgL = \frac{1}{2}mv_b^2$$

$$mgL = \frac{1}{2}mv_t^2 + 2(L-d)mg$$

$$\frac{1}{2}v_t^2 = (2d-L)g$$

$$v_t = \sqrt{2(2d-L)g}$$



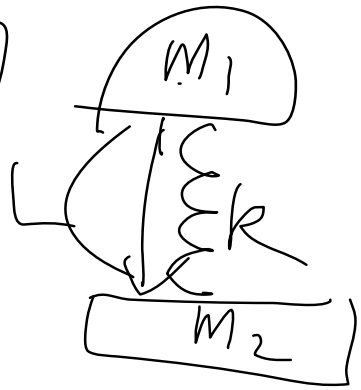


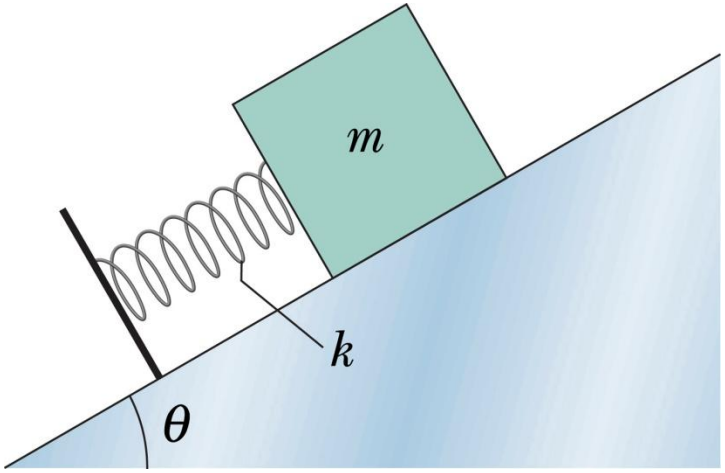
(a) 줄어든 길이 L $k?$
(b) 더 누른 길이 l
(c) Highest point

$mg = kL$ $\quad k = \frac{mg}{L}$

$$\frac{1}{2}\frac{mg}{L}(L+l)^2 = mgh$$

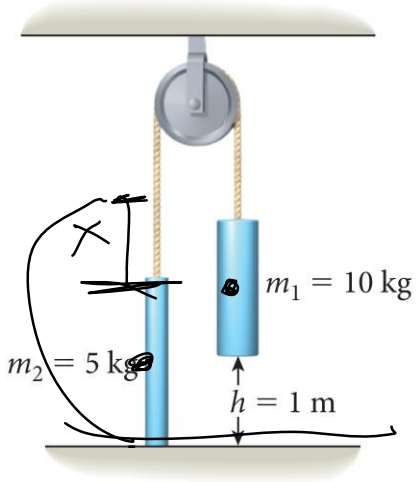
$$h = \frac{(L+l)^2}{2L}$$




m
k
θ

Prob. 6.64

$h + x = h$ $\quad \frac{2m_1}{m_1+m_2}$



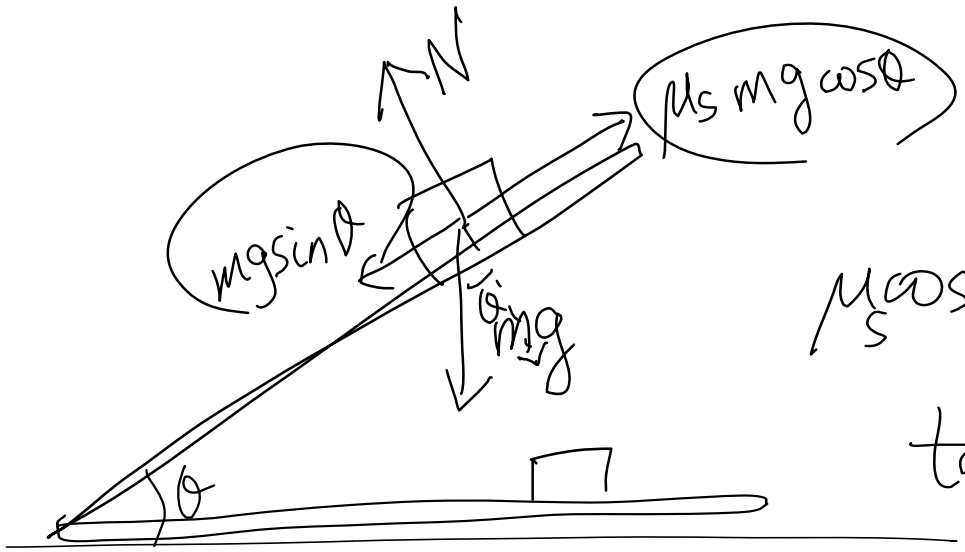
Velocity?

$$m_1 g h = m_2 g h + \frac{1}{2}(m_1+m_2)v^2$$

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

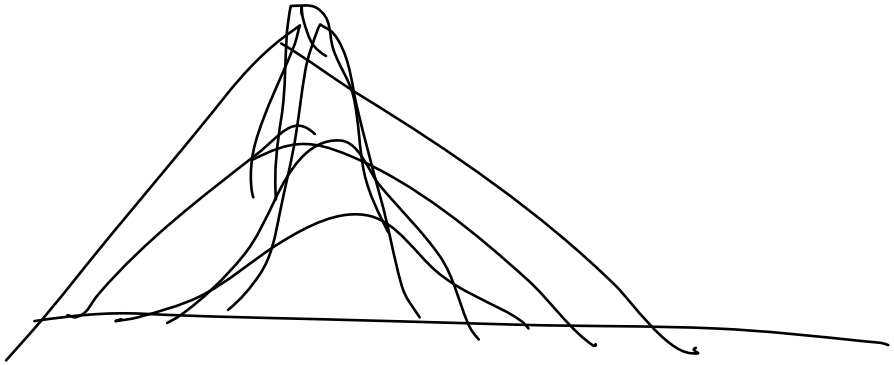
$$\frac{1}{2}m_2 v^2 = m_2 g x$$

$$x = \frac{1}{2g}\cdot\frac{2(m_1-m_2)gh}{m_1+m_2} = \frac{m_1-m_2}{m_1+m_2}h$$

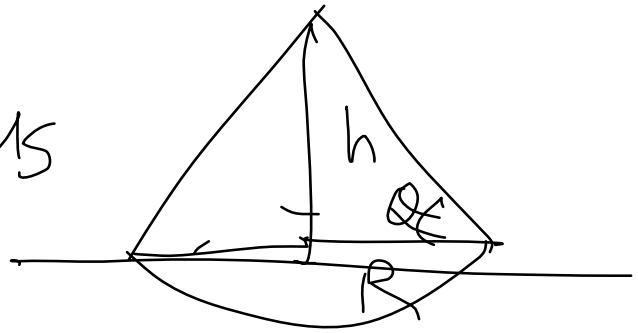


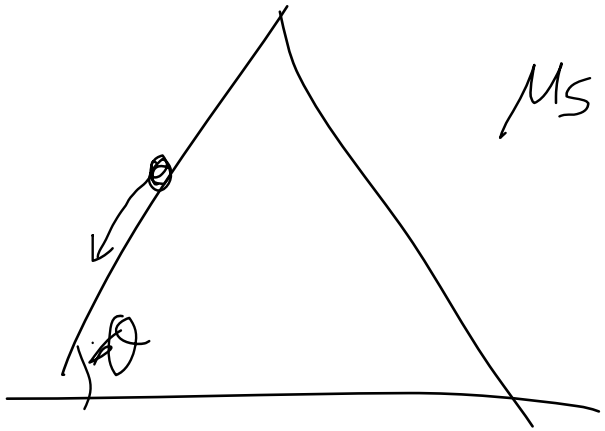
$$\mu_s \cos\theta = \sin\theta$$

$$\tan\theta = \mu_s$$



μ_s





$\mu_s \tan\theta$

$\tan\theta = \frac{h}{R} = \mu_s$

$h = R\tan\theta$

$h = R\mu_s$

$$V = \frac{1}{3}\pi R^2 R\mu_s = \frac{\pi}{3}\mu_s R^3$$