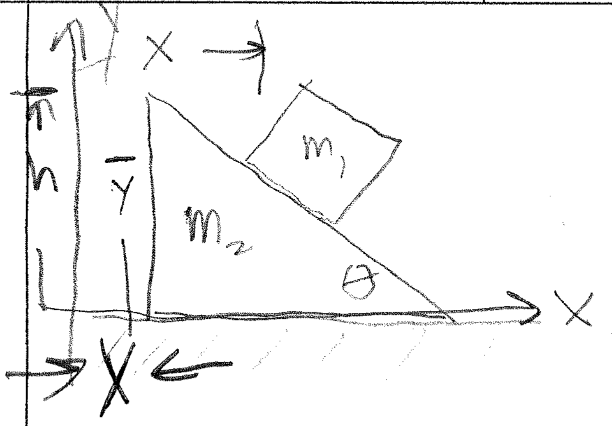



h = height of incline.

$y_1$ = elevation of little block.

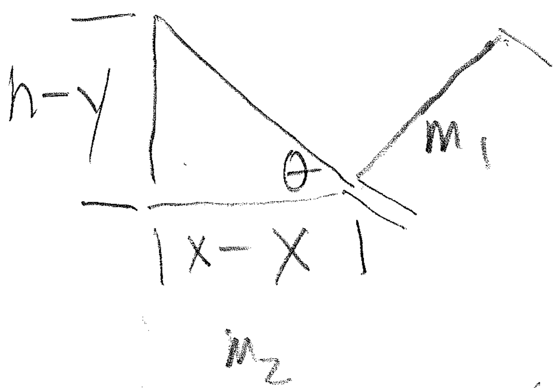
x = horizontal coordinate of little block

X = horizontal coordinate of big block.

No Friction!

Coordinates

Constraint:



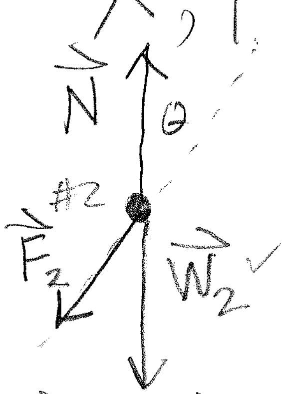

$$\tan\theta = \frac{h-y}{x-X}$$

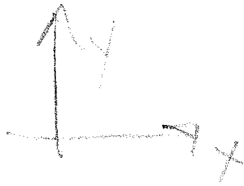
$$(x-X)\tan\theta = h-y$$

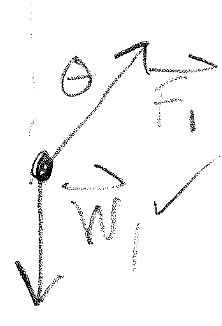
$$(\dot{x}-\dot{X})\tan\theta = -\dot{y}$$

$$(\ddot{x}-\ddot{X})\tan\theta = -\ddot{y}$$

$X, Y_1$ = constant




x, y

$$\vec{F}_2 = -\vec{F}_1$$

$$m_2\ddot{X} = -F_1\sin\theta$$

$$0 = N - F_1\cos\theta - m_2 g$$

$$m_1\ddot{x} = F_1\sin\theta$$

$$m_1\ddot{y} = F_1\cos\theta - m_1 g$$

Go for $\ddot{y}$ → eliminate all else (like 2.16 on homework).

$$\ddot{x} = -\frac{F_1}{m_2}\sin\theta$$

$$\left(\ddot{x} + \frac{F_1}{m_2}\sin\theta\right)\tan\theta = -\ddot{y}$$

$$\ddot{x}\tan\theta = -\ddot{y} - \frac{F_1}{m_2}\sin\theta\tan\theta$$

$$\ddot{x} = \frac{-\ddot{y}}{\tan\theta} - \frac{F_1}{m_2}\sin\theta$$

$$\frac{-m_1\ddot{y}}{\tan\theta} - \frac{m_1}{m_2}F_1\sin\theta = F_1\sin\theta$$

$$\frac{-m_1\ddot{y}}{\tan\theta} = \left(1 + \frac{m_1}{m_2}\right)F_1\sin\theta$$

$$F_1 = -\frac{m_1}{1 + \frac{m_1}{m_2}}\frac{1}{\tan\theta\sin\theta}\ddot{y}$$

$$= -\underbrace{\frac{m_2 m_1}{m_1 + m_2}}_{\text{called "reduced mass"}}\frac{1}{\tan\theta\sin\theta}\ddot{y}$$

$\mu$

$$\mu = \frac{m_1 m_2}{m_1 + m_2}$$
$$\frac{1}{\mu} = \frac{1}{m_1} + \frac{1}{m_2}$$

$\mu$ smaller than either

$$m_1 \ddot{y} = -\mu \frac{1}{\tan\theta \sin\theta} \cos\theta \ddot{y} - m_1 g$$

$$\left(m_1 + \frac{\mu}{\tan^2\theta}\right)\ddot{y} = -m_1 g$$

$$\boxed{\ddot{y} = \frac{-m_1}{m_1 + \frac{\mu}{\tan^2\theta}} g = \frac{-1}{1+\left(\frac{\mu}{m_1}\right)\frac{1}{\tan^2\theta}} g}$$

(a) $\theta = 90^0 = \pi/2$, $\tan\theta \to \infty$

$$\ddot{y} = -g$$

(b) $\theta = 0^0 = 0$, $\tan\theta \to 0$

(c) $m_2 \to \infty$

$\to \frac{-\tan^2\theta}{1+\tan^2\theta} g \to -\sin^2\theta g$ $\quad \ddot{y} \to 0$

(d) $m_1 \to \infty \to -g$

$$\boxed{F_1 = -\mu \frac{1}{\tan\theta \sin\theta} \ddot{y} = \frac{+\frac{\mu}{\tan\theta \sin\theta}}{1+\left(\frac{\mu}{m_1}\right)\frac{1}{\tan^2\theta}} g}$$

(a) $\theta = 90^0 = \pi/2$, $\tan\theta \to \infty$

$$F_1 \to \frac{\mu}{\tan\theta \sin\theta} g \to \underline{\mu g \cos\theta}$$

$\to 0!$

(b) $\theta = 0^0 = 0$, $\to \frac{\frac{\mu}{\tan\theta \sin\theta}}{\frac{\mu}{m_1}\frac{1}{\tan^2\theta}} g \to \frac{m_1 g}{\cos\theta} \to$

$m_1 g$

$$\ddot{X} = -\frac{F_1}{m_2} \sin\theta$$

$$= \frac{-\left(\frac{\nu}{m_2}\right) \frac{1}{\tan\theta \cancel{\sin\theta}} \cdot \cancel{\sin\theta}}{1 + \left(\frac{\nu}{m_1}\right)\frac{1}{\tan^2\theta}} g$$

$$\boxed{\ddot{X} = \frac{-\left(\frac{\nu}{m_2}\right)\frac{1}{\tan\theta}}{1 + \left(\frac{\nu}{m_1}\right)\frac{1}{\tan^2\theta}} g}$$

$\theta \to 90^\circ = \pi/2$, $\tan\theta \to \infty$

$$\ddot{X} \to -\frac{\nu}{m_2}\frac{1}{\tan\theta} g \to 0$$

$\theta \to 0^\circ \to 0$

$$\ddot{X} \to \frac{-\frac{\nu}{m_2}\frac{1}{\tan\theta}}{\frac{\nu}{m_1}\frac{1}{\tan^2\theta}} g$$

$$\to -\frac{m_1}{m_2}\tan\theta\, g \to 0$$

WHEN IS $\ddot{X}$ MAXIMUM?