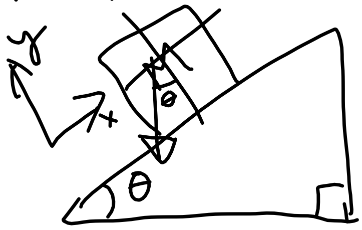
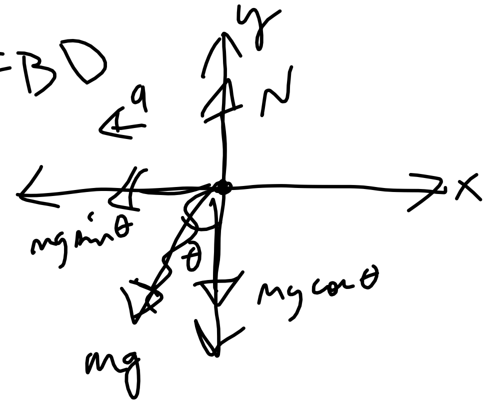
Frictionless ramp (see ex 5.12)



FBD



2^{nd} Law: $\sum F_x = -ma$

$-mg\sin\theta = -ma \qquad a = g\sin\theta$

$\sum F_y = 0 \qquad N - mg\cos\theta = 0$

$N = m\cos\theta$

Sep 21-9:37 AM

Suppose we imagine that $\overrightarrow{a}$

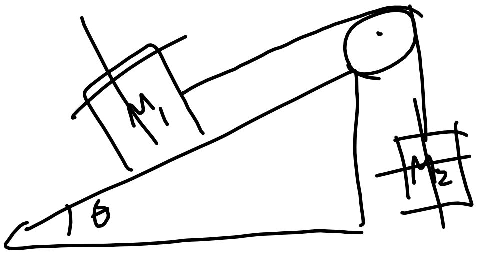
$\sum F_x = ma$

$-mg\sin\theta = ma \Rightarrow a = -g\sin\theta$

minus sign because acceleration is in the negative x direction

Sep 21-9:48 AM

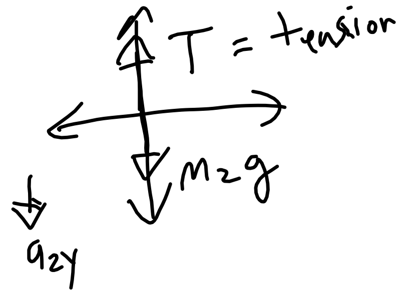
Example problem II



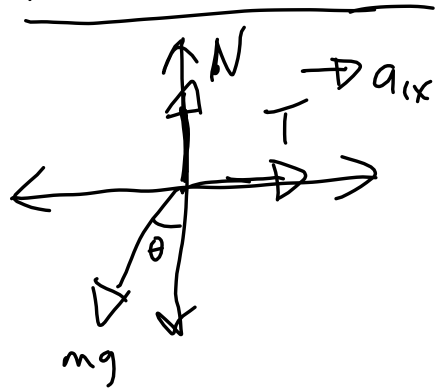
still frictionless, but now we have tension

Pulley is frictionless, massless. Rope is massless.

FBD for mass 2



FBD for mass 1



Sep 21-9:50 AM

If rope is taught: $|a_{1x}| = |a_{2y}|$

$|v_{1x}| = |v_{2y}|$

2nd law: mass 2: $\sum F_x = 0$ $\quad \sum F_y = -m_2 a_{2y}$

$$T - m_2 g = -m_2 a_{2y}$$

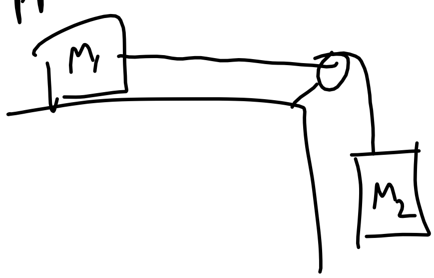
mass 1: $\sum F_x = m_1 a_{1x}$ $\quad \sum F_y = 0$

$$T - m_1 g \sin\theta = m_1 a_{1x} \qquad N - m_1 g \cos\theta = 0$$

If we are given θ, m_1 and m_2 we can find $a = |a_{1x}| = |a_{2y}|$, T

Sep 21-9:58 AM

Suppose $\theta = 0$. Then trivial problem



Then $T = m_1 a$

$T = m_2(g - a)$

acceleration is $a = \dfrac{T}{m_1}$

substitute, solve for T

$$T = \left(\frac{m_1 m_2}{m_1 + m_2}\right) g$$

$T = m_2 g$

Note if m_2 is justing hanging there,

Sep 21-10:05 AM

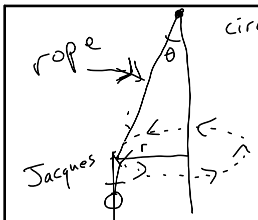
But in this case,

$$T = \underbrace{\left(\frac{m_1}{m_1 + m_2}\right)}_{\leq 1} m_2 g$$

So tension is always less than it would be for hanging mass

$$a = \frac{m_2}{m_1 + m_2} g$$

Sep 21-10:10 AM



cirque du soleil

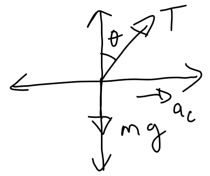
suppose $m = 70$ kg

$r = 10$ m

$L = 20$ m

$\theta = \sin^{-1}\left(\frac{r}{L}\right) = 30°$

FBD for Jacques



2nd law

$\Sigma F_y = 0$

$T\cos\theta = mg$

$\Sigma F_x = ma_c$

$T\sin\theta = ma_c$

$$\frac{\cancel{T}\sin\theta = \cancel{m}a_c}{\cancel{T}\cos\theta = \cancel{m}g} \qquad \tan\theta = \frac{a_c}{g}$$

$$a_c = g\tan\theta$$

$$= (9.8\ \text{m/s}^2)(0.58)$$

$$= 5.7\ \text{m/s}^2$$

Sep 21-10:16 AM

Now we can calculate the tension,

$$T = \frac{mg}{\cos\theta} = \frac{700\text{ N}}{0.86} \simeq 800\text{ N}$$

I hope this is consistent with

$$T = \frac{ma_c}{\sin\theta} = \frac{(70\text{ kg})(5.7\text{ m/s}^2)}{0.5}$$

$\simeq 800$N yay!

Now, $a_c = \frac{v^2}{r}$, in principle, we can find the velocity

$$v = \sqrt{r a_c} = \sqrt{(10\text{ m})(5.7\text{ m/s}^2)} = 7.5\text{ m/s}$$

Recall that $\omega = \frac{v}{r}$ (recall that $v = r\omega$)

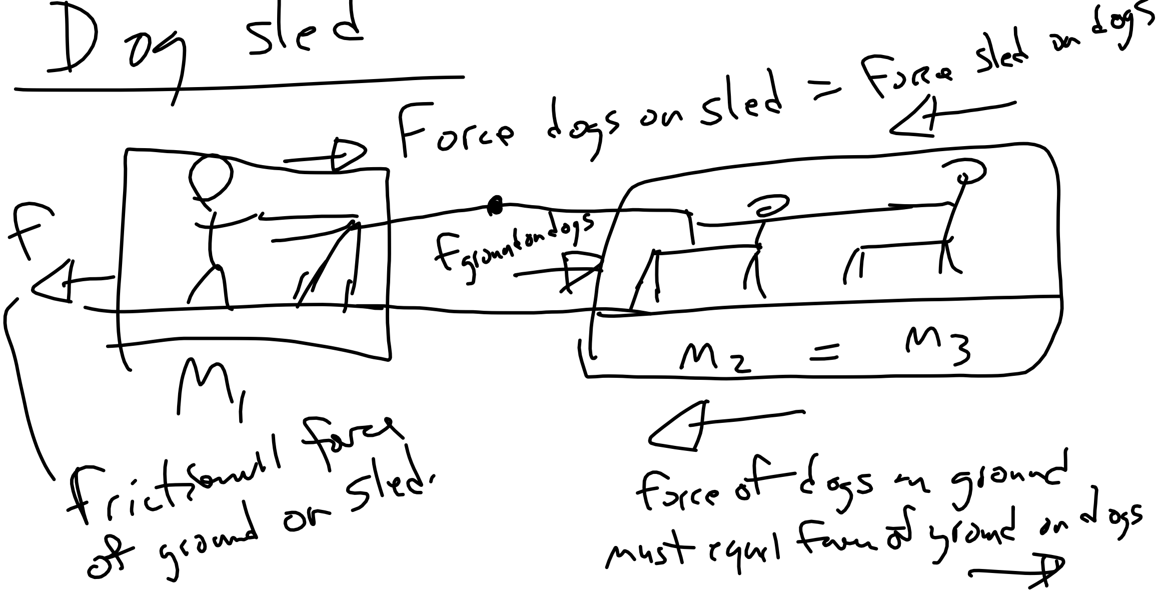
$$\omega = \frac{7.5\text{ m/s}}{10\text{ m}} = 0.75\ \frac{\text{rad}}{\text{s}}$$

Sep 21-10:28 AM

Time to complete one revolution is

$$T = \frac{2\pi}{\omega} \cong \frac{6}{0.75} \approx 8 \text{ s}$$

Dog sled



Sep 21-10:37 AM

Sep 21-10:38 AM

Sep 21-10:28 AM

Sep 21-10:11 AM