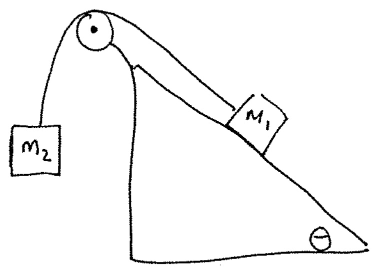
Lecture 13

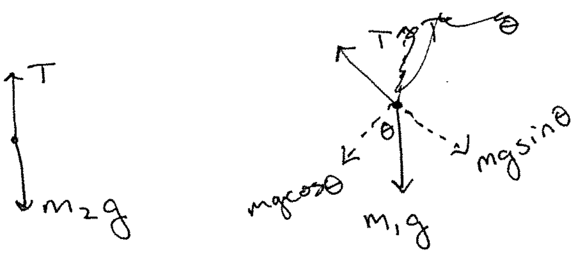
Example



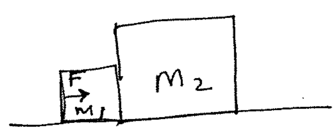
which way?

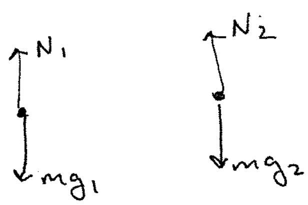
$a = ?$

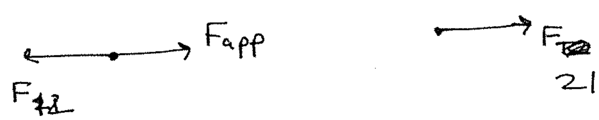
$T = ?$



F_{CE}
on by



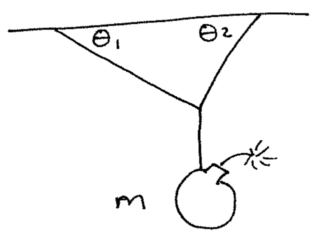


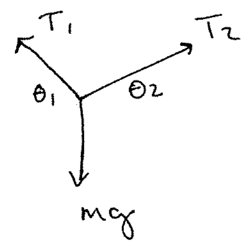


$F_{app} = (m_1 + m_2) a$

$a = \frac{F_{app}}{m_1 + m_2}$

~~$F_{app} - F_{21} = m_2 a$~~ $F_{21} = m_2 a$





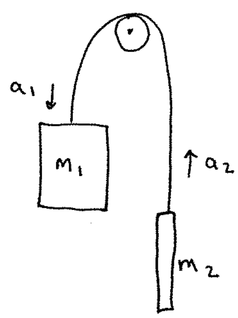
equilibrium:

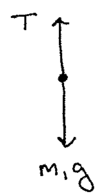
$\Sigma F = 0$

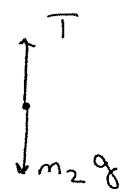
y-dir $\quad T_1 \sin\theta_1 + T_2 \sin\theta_2 = mg$

x-dir $\quad -T_1 \cos\theta_1 + T_2 \cos\theta_2 = 0$

<u>Atwood's Machine</u>



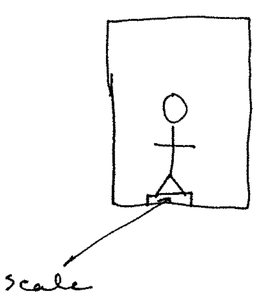




$T - m_1 g = a_1$ $\qquad T - m_2 g = a_2$

$a_1 = -a_2$ $\qquad \searrow (m_1 - m_2) g = a$

Inside elevator (non-inertial frame)



If v constant, $a = 0 \rightarrow \Sigma F = 0$

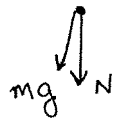
$\Sigma F_y = N - mg = 0$

$\therefore N = mg$

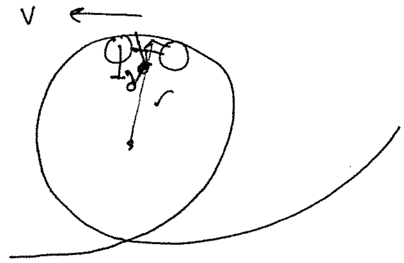
If slowing down $(a < 0)$

$N - mg = ma$

$N = m(g + a)$ $\qquad$ a neg $\Rightarrow$ scale reads light!



$\downarrow +y$



$$\Sigma F_y = N + mg = ma \qquad a = \frac{v^2}{r}$$

$$N + mg = m\frac{v^2}{r}$$

limit → $N = 0$ → slowest v to not fall.

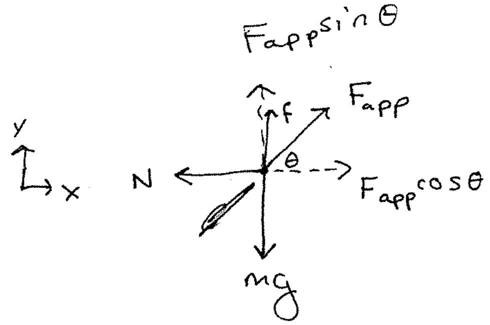
$$v = \sqrt{rg}$$

Ex 6.3.8

$m = 1\,kg$

$F = 8.0N$

$\theta = 45°$



$\uparrow f_s ? = \mu_s N$

$\downarrow$

$N = F_{app}\cos\theta$

$f_s = \mu_s F_{app}\cos\theta$

$F_{app}\sin\theta - mg + f_s = 0$?

$F_{app}\sin\theta = 8.0N \sin 45° = 5.66N$

$mg = (1kg)(9.8m/s^2)$

$= 9.8N$

$\Rightarrow f_s$ is upward.

$f_s = mg - F_{app}\sin\theta$

$= 9.8N - 5.66N = 4.1N$

Ex 6.27

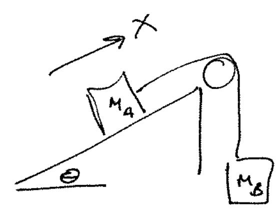
$m_A = 102N$

$m_B = 32N$

$\mu_s = 0.56$

$\mu_K = 0.25$

$\theta = 40°$

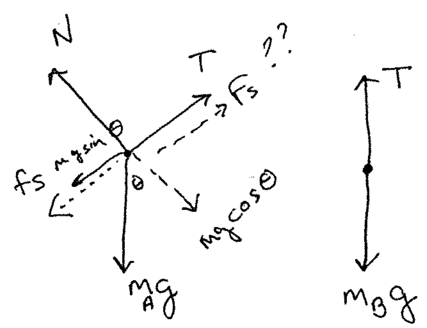


$a_A = ?$

a) A initially at rest

b) up ↙ f_K

c) down ↗ f_K



a) if at rest f_s dir? guess down.

$T - f_s - m_A g \sin\theta = 0$ (at rest) stays that way

$N = m_A g \cos\theta$

$T = m_B g$

$\Rightarrow f_s = T - m_A g \sin\theta$

$= m_B g - m_A g \sin\theta$

$= 32\,N - 102\,N \sin\theta = -34\,N$

$f_{s_{max}} = \mu_s N = \mu_s m_A g \cos\theta = (.56)(102\,N)\cos 40^\circ$

$= 44\,N$

$f_s < f_{s_{max}} \Rightarrow$ stays stationary.

f_s is uphill, not down.

b) $T - f_K - m_A g \sin\theta = m_A a_x$

$-m_B a_B + m_B g - \mu_K N - m_A g \sin\theta = m_A a_x$

$m_B g - \mu_K m_A g \cos\theta - m_A g \sin\theta = m_A a_x + m_B a_B$

$a_B = a_x$

$T - m_B g = -m_B a_B$

$a(m_A + m_B) = m_B g - \mu_K m_A g \cos\theta - m_A g \sin\theta$

$a = -3.9\,m/s^2$

accelerating down plane

move upward, slowing down.

c) $T + f_K - m_A g \sin\theta = m_A a$

$-m_B a_B + m_B g + \mu_K N - m_A g \sin\theta = m_A a$

$a(m_A + m_B) = m_B g + \mu_K m_A g \cos\theta - m_A g \sin\theta$

$a = -1.0\,m/s^2$

accelerating down plane

speeding up