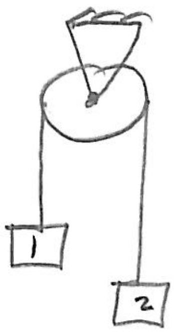
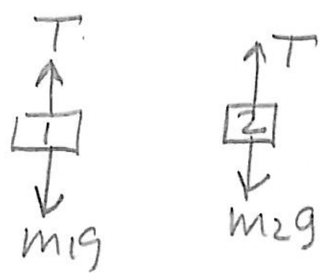
Atwood's Machine

29:011



1) Free Body Diagrams



2) choose direction $\uparrow +$

3) apply $F = ma$ to both masses

1: $T - m_1 g = m_1 a_1$

2: $T - m_2 g = m_2 a_2$

4) Realize that magnitude of accelerations is the same, but one is up and one is down — CHOOSE $a_1 = +a$, $a_2 = -a$

5) Rewrite equations

$T - m_1 g = m_1 a$ ---- ①

$T - m_2 g = -m_2 a$ ---- ②

Solve ① for T: $T = m_1 g + m_1 a$, substitute T in ②: $m_1 g + m_1 a - m_2 g = -m_2 a$

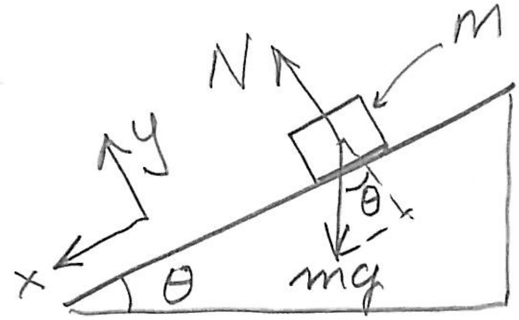
6) Solve for a $(m_1 + m_2) a = (m_2 - m_1) g$

or $\boxed{a = (m_2 - m_1) g / (m_1 + m_2)}$

7) Does it make sense? — suppose $m_2 > m_1$ then $a_1 = a > 0 \rightarrow$ ① goes up and ② goes down, as <u>expected</u>.

Inclined Plane

1) no friction



mg: down
N: ⊥ to plane

- DRAW FREE Body DIAGRAM WITH ALL FORCES
- Choose coordinate axes — convenient to take x down plane and y perp. to plane
- Apply $\vec{F} = m\vec{a}$

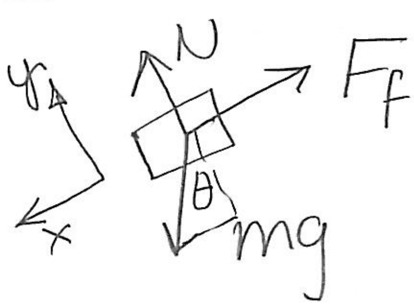
$$F_{net,x} = ma_x$$

$$\cancel{m}g\sin\theta = \cancel{m}a_x \Rightarrow \underline{a_x = g\sin\theta}$$

$$F_{net,y} = N - mg\cos\theta = ma_y = m(0) = 0$$

$$\underline{N = mg\cos\theta}$$

2) Add friction



Friction FORCE

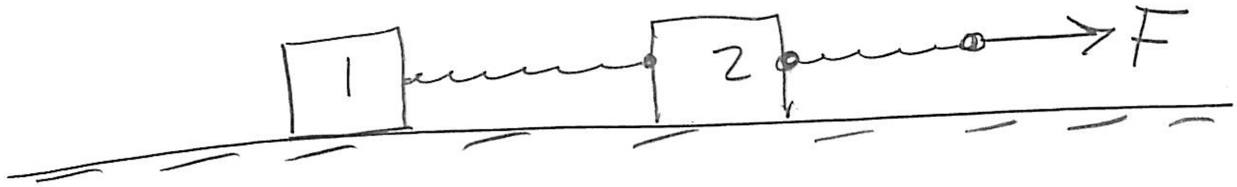
Friction always acts opposite to direction of motion.

$$N = mg\cos\theta \quad \text{(same as before)}$$

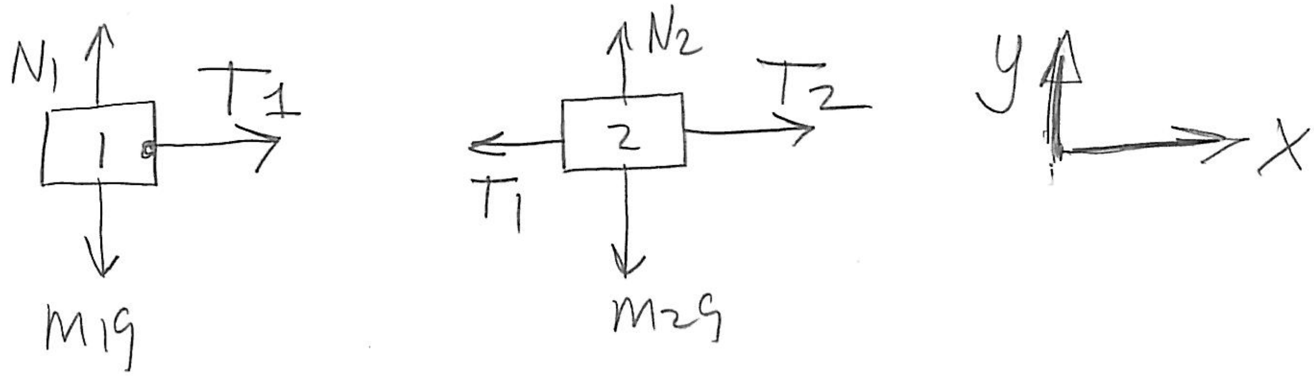
$$mg\sin\theta - F_f = ma_x$$

For block to slide $\quad mg\sin\theta > F_f$

Blocks in Tandem



FIND Accel. of blocks and Tension in cord connecting ① & ②



$T_1 = m_1 a_1$ $\qquad\qquad$ $T_2 - T_1 = m_2 a_2$

if strings are ideal $\quad T_2 = F$

now $a_1 = a_2 = a$

$F - T_1 = m_2 a_2$

$F - m_1 a = m_2 a \Rightarrow \quad \underline{F = (m_1 + m_2)\, a}$

F accelerates the system

Then: $\boxed{T_1 = m_1 a = \left(\dfrac{m_1}{m_1 + m_2}\right) F}$