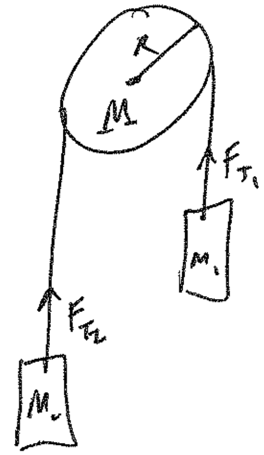
Atwood with massive pulley (assume $m_1 > m_2$)



① $\Sigma F_1 = m_1 a = m_1 g - F_{T_1}$

② $\Sigma F_2 = m_2 a = F_{T_2} - m_2 g$

③ $\Sigma \tau = I\alpha = (F_{T_1} - F_{T_2})R$

for uniform cylinder, $I = \frac{1}{2} M R^2$
and $a = \alpha R$ (no slipping)

① $F_{T_1} = m_1 g - m_1 a$

② $F_{T_2} = m_2 a + m_2 g$

③ $\frac{1}{2} M R^2 (\alpha) = (m_1 g - m_1 a - m_2 a - m_2 g) R$

$\frac{1}{2} M R^{\not{2}} \left(\frac{a}{\not{R}}\right) = (m_1 g - m_1 a - m_2 a - m_2 g) \not{R}$

$\frac{1}{2} M a = m_1 g - m_1 a - m_2 a - m_2 g$

$\frac{1}{2} M a + m_1 a + m_2 a = (m_1 - m_2) g$

$a\left(m_1 + m_2 + \frac{M}{2}\right) = (m_1 - m_2) g$

$$\boxed{a = \frac{(m_1 - m_2)}{\left(m_1 + m_2 + M/2\right)} g}$$