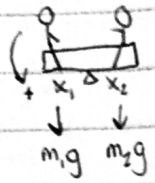
Static Equilibrium

$\Sigma \vec{F} = m\vec{a} \Rightarrow \Sigma \vec{F} = 0$
$\Sigma \vec{\tau} = 0$
} Conditions

Example #1

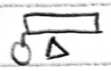
$m_1 = 20\,kg$
$m_1 = 30\,kg$
$m_2 = 25\,kg$
$x_1 = 2.5\,m$
$x_2 = ?$



$\tau_1 + \tau_2 = 0$

$x_2 = \frac{m_1 g x_1}{m_2 g} = \frac{30(9.8)(2.5)}{25(9.8)} = \boxed{3m}$

Example #2

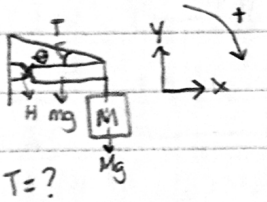


$m_{rod} = \boxed{1\,kg}$

Example #3

$L = 2.2\,m$
$m = 25\,kg$
$\theta = 30°$
$M = 280\,kg$

$T = ?$
$H = ?$



$\Sigma \vec{F} = 0 \begin{cases} F_x = H_x - T_x = 0 \\ F_y = H_y + T_x - mg - Mg = 0 \end{cases}$

$\Sigma \vec{\tau} = 0 = \tau_{H_x} + \tau_{H_y} + \tau_{mg} + \tau_{T_x} + \tau_{T_y} + \tau_{Mg}$ (τ_{H_x}, τ_{H_y}, τ_{T_x} = 0)

$\tau_{mg} - \tau_{T_y} + \tau_{Mg} = 0$

$\frac{1}{2}\cancel{L}mg - T_y\cancel{L} + Mg\cancel{L} = 0 = \frac{1}{2}mg - T_y + Mg$

$T_y = 2866.5\,N$

$\frac{1}{2}(25)(9.8) + 280(9.8) = T_y$

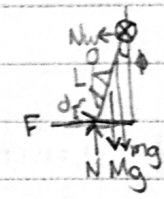
$T = \frac{T_y}{\tan\theta} = \frac{2866.5}{\tan 30}$

$\boxed{T_x = 4964.9\,N}$

$\boxed{H_x = 4964.9\,N}$ $\boxed{H_y = 122.5\,N}$

* Example #4

M $F(d) = ?$
m
L
ϕ



$\Sigma \vec{F} = 0 \begin{cases} F_x = F - N_W = 0 \\ F_y = N - Mg - mg = 0 \quad N = Mg + mg \end{cases}$

$\Sigma \vec{\tau} = 0 = \tau_N + \tau_F + \tau_{Mg} + \tau_{mg} + \tau_{N_W}$ (τ_{N_W} = 0)

$\tau_N - \tau_F - \tau_{Mg} - \tau_{mg}$

$NL\sin\phi - FL\frac{\sin(90-\phi)}{\cos\phi} - Mg(L-d)\sin\phi - \frac{1}{2}mgL\sin\phi = 0$

$F = \tan\phi\left(N - Mg + \frac{Mgd}{L} - \frac{mg}{2}\right)$

$\boxed{F = g\tan\phi\left(\frac{m}{2} + \frac{Md}{L}\right)}$

$F_{max} = \mu_s(mg + Mg) = \boxed{\mu_s g(m+M)}$

$\left(F\cancel{L}\cos\phi = N\cancel{L}\sin\phi - mg\cancel{L}\sin\phi + \frac{mgd}{\cancel{L}}\sin\phi - \frac{1}{2}mg\cancel{L}\sin\phi\right)/\cos\phi$