1 Friction

1.1 Example 1

1.2 Example 2

$$\begin{aligned}
\mu_R &= 0.1 \\
\mu_{\text{max}} &= 0.3 \\
m &= 1\,\text{kg} \\
\theta &= 15^\circ
\end{aligned}$$

What is the range of force values for which the system is static?

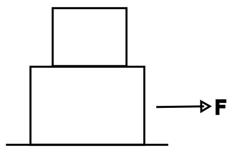
$$\begin{aligned}
\sum F_x^{\text{min}} &= 0 \\
N &= F_{\text{min}} \sin(\theta)
\end{aligned}$$

$$\begin{aligned}
\sum F_y^{\text{min}} &= 0 \\
f_{\text{min}} + F_{\text{min}} \cos(\theta) &= mg \\
\mu_{\text{max}}(F_{\text{min}} \sin(\theta)) + F_{\text{min}} \cos(\theta) &= mg \\
F_{\text{min}} &= \frac{mg}{\cos(\theta) + \mu_{\text{max}} \sin(\theta)} \\
\therefore \quad F_{\text{max}} &= \frac{mg}{\cos(\theta) - \mu_{\text{min}} \sin(\theta)}
\end{aligned}$$

1.3 Example 3

$$\begin{aligned}
F &= ? \\
m_1 &= 10\,\text{kg} \\
\mu_k &= 0.1 \\
m_2 &= 5\,\text{kg} \\
\mu_{\text{max}} &= 0.4 \\
a &= ?
\end{aligned}$$

1.4 Example 4



$$
\begin{aligned}
m_1 &= 2\,\mathrm{kg} \\
m_2 &= 5\,\mathrm{kg} \\
u_{\mathrm{max}} &= 0.5 \\
u_k &= 0.2 \\
a_{\mathrm{bottom}} &= a_{\mathrm{top}} = a \\
F &= ?
\end{aligned}
$$

How much force is needed to move the bottom block while the top stays static?

$$
\begin{aligned}
\sum F_y^{(m_2+m_1)} &= 0 \\
N_{g,b} &= (m_1+m_2)g
\end{aligned}
$$

$$
\begin{aligned}
\sum F_x^{(m_2+m_1)} &= 0 \\
F &= f_{g,b} \\
F &= \mu_{\mathrm{max}} N_{g,b} \\
F &= \mu_{\mathrm{max}}(m_2+m_1)g \\
F &= 0.5(70\,\mathrm{N}) \\
F &= 35\,\mathrm{N}
\end{aligned}
$$

$$
\begin{aligned}
\sum F_y^{(m)} &= 0 \\
N_{t,b} &= mg
\end{aligned}
$$

$$
\begin{aligned}
\sum F_x^{(m)} &= ma \\
f_{t,b} &= ma \\
a &= \frac{f_{t,b}}{m} \\
a &= \frac{\mu_{\mathrm{max}} mg}{g} \\
a &= \mu_{\mathrm{max}} g = (0.5)(10\,\mathrm{m\,s^{-2}}) \\
a &= 5\,\mathrm{m\,s^{-2}}
\end{aligned}
$$

$$
\begin{aligned}
\sum F_y^{(m_2+m_1)} &= 0 \\
N_{g,b} &= (m_1+m_2)g = 70\,\mathrm{N}
\end{aligned}
$$

$$
\begin{aligned}
\sum F_x^{(m_2+m_1)} &= (m_2+m_1)a \\
F - f_{g,b} &= (m_2+m_1)a \\
F &= (m_1+m_2)a + \mu_k N_{g,b} \\
F &= 49\,\mathrm{N}
\end{aligned}
$$