Example: Our stuntman wishes to reach the top of an incline of length \( d \) and angle \( \theta \) with the vertical, and still have enough speed to jump a gap of length \( X \). Our stuntman will employ the aid of a jet pack that pushes on him, parallel to the surface he resides on. He starts at the bottom of the hill (ignore the spring and the flat ground) from rest and must overcome the friction (coefficient \( \mu_k \)) between the ramp and his skis. What must the thrust from the jetpack be to achieve this great stunt if his jetpack shuts off at the top of the ramp?

**Constrained Systems: Methods for Analyzing**

* Identify system(s) + draw FBD’s
* ” ” 3rd Law F.P.’s
* ” ” Constraints that connect systems
* 2nd Law & Solve, \( \Sigma F_{ext} = m \ddot{a}_{con} \)

\[
\begin{align*}
\Sigma F_x &= F_{th} - \mu_k (mg \sin \theta) - mg \cos \theta = ma_x \\
\alpha_x &= \frac{F_{th}}{m} - g (\mu_k \sin \theta + \cos \theta) \\
V_b^2 &= V_a^{20} + 2a_x d \\
V_0^* &= 2d \left( \frac{F_{th}}{m} - g (\mu_k \sin \theta + \cos \theta) \right) \\
F_{th} &= \left[ \frac{g X}{1 + \mu_k \cos \theta \tan \theta} + g (\mu_k \sin \theta + \cos \theta) \right] m
\end{align*}
\]
Example: What minimum force must be exerted on block A in order for block B not to fall? The coefficient for static friction between blocks A and B is 0.55 and the horizontal surface is frictionless. (Answer: 1960 N)
Example: A 4.0-kg block rests atop a 3.0-kg block. If the coefficient of static friction between the blocks is 0.4, and there is no friction between the 3.0-kg block and the bottom surface, what is the maximum horizontal force that can be applied to the 4.0-kg block and the two not slip relative to each other? (Answer: 36.6 N)

\[ F_{\text{max}} = \frac{m_4 g}{m_2 + m_4} \]

\[ \text{Solution: } F_{\text{max}} = 33.4 \text{ N} \]
Example: A block of mass 6.03 kg lies on a frictionless horizontal surface. The block is connected by a light cord over a massless, frictionless pulley to another block of mass 4.68 kg, which hangs in the air. Calculate the acceleration of the first block. (Answer: 4.28 m/s²)