Example: A 80 kg man, wearing skis on snow (no friction), is pulled via a rope from a truck on level ground. The magnitude of the force from the truck 800 N and is directed at an angle of 30° above the horizontal.

(a) What is the man's acceleration? (Answer = <8.66, 0>m/s²)

(b) If he starts from rest, what is his position and velocity as a function of time? (I'll use g = 10 m/s²)

\[ \Sigma F_x \Rightarrow F_T \cos \theta = Ma_x \Rightarrow a_x = 8.66 \text{m/s}^2 \]

\[ \Sigma F_y \Rightarrow F - F_T \sin \theta - mg = Ma_y \Rightarrow a_y = 0 \text{m/s}^2 \]

(b) \[ \ddot{a} = \text{const} \ldots \text{km eq's for const. } \ddot{a} \]

\[ \Delta x(t) = V_{x0} t + \frac{1}{2} a_x t^2 \Rightarrow \Delta x(t) = 4.33t^2 \]

\[ V_x(t) = V_{x0} + a_x t \Rightarrow V_t(t) = 8.66t \]

**Friction**

Hard to break free ... easier to keep moving once free

\[ F^a \]

\[ F^k \]

\[ F_s \]
Example: A 80 kg man, wearing skis on snow, is pulled via a rope from a truck on level ground. The force from the truck is directed at an angle of 30° above the horizontal.

For part (c) and (d) consider friction present with $\mu_s = 1/3$ and $\mu_k = 1/4$.

(c) How much tension is required to get the skier to slip? (261 N)
(d) If the minimum slip tension is doubled, what will the acceleration be? (4.08 m/s²)

\[ F_{min} \rightarrow \text{Slip} \]

Solve w/ static + use max frict.

\[ \sum F_y = 0 \Rightarrow F^r + F_{sk} \sin \theta + (-mg) = m\ddot{y} \Rightarrow F^r = mg - F_{sk}\sin \theta \]

\[ \sum F_x = 0 \Rightarrow F^r \cos \theta - M_s (mg - F_{sk}\sin \theta) = M\ddot{x} \]
Example: A force is applied to a 1-kg-block that is pressed against a vertical wall. The force is at an angle of 40° upward from the horizontal. If the coefficient of static friction between the block and the wall is 0.3, what range of forces will keep the block in equilibrium? (Answer = 11.2 – 23.7 N)

\[ \Sigma F_x \Rightarrow F_t \cos \theta - M_s \left( mg - F_t \sin \theta \right) = M a_x \]
\[ F_{n} \]
\[ F_{s, \text{max}} \]
\[ F_{s, \text{min}} > \frac{M_s mg}{\cos \theta + M_s \sin \theta} > 261 \text{ N} \]

(d) \[ F_{t, \text{min}} \rightarrow 2 F_{t, \text{min}}, \quad F_{s, \text{max}} \rightarrow F_{s, \text{k}} \]
\[ \Sigma F_x \Rightarrow F_t \left( \cos \theta - M_k \sin \theta \right) - M_k mg = M A_x, \quad \boxed{a_x = 4.08 \text{ m/s}^2} \]
\[ \Sigma F_y \Rightarrow F_t < mg \quad \text{so} \quad \boxed{a_y = 0} \]

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?

\[ \text{Friction can point up or down depending on } |F_a| \]