1st law
→ acceleration = 0
3 laws

velocity
acceleration

Simple
1. D motion:
T_1, T_2, T_3, T_4, T_f

Friction
F_f = Friction force
cold

Ticky
object
F_f = \frac{N}{mg} \quad (Normal force or acceleration)

but there is no acceleration
frictional force
increase force until

F_f = \mu N  \quad \mu_s = static \quad \mu_k = kinetic

\mu_s > \mu_k

Slope
\mu_g \quad \frac{F_f}{mg} = \mu \quad N = mg \cos \theta

evaluate that
very minor

slide down hill
Breaks loose

\theta \uparrow
NeUtons 4th law
Mg \sin \theta - F_{fmax} = 0
\[
\begin{align*}
\mu \times \cos \alpha &= \mu_0 \times \cos \alpha = 0 \\
\sin \alpha &= \mu_0 + \cos \alpha = 0 \\
\mu_0 &= \tan \alpha \\
\text{NB No Mass} & \rightarrow \text{independent of mass only on the material}\end{align*}
\]

independent of area of contact

Problem \rightarrow \text{water or chalk} \rightarrow \text{influences the friction coefficient}

Plastic bin vs. rubber pluck. Different increase rubber

Mass experiment same for angle roughly

Surface Area no effects for mass

\begin{align*}
\text{Measurement Method } (2) \rightarrow \text{put on an incline direction of acceleration}
\end{align*}

Trivial force is undefined could be +ve or -ve.

\[
F_{\text{max}} = \mu_0 m_1 g \cos \alpha.
\]
3. Situation

Situation 1 : acceleration

\[ T - m_g \sin \alpha - F_{\text{max}} = 0 \]

No acceleration.

System is at Rest.

Thus \[ T = m_g \]

\[ F_{\text{max}} = T = m_g \]

\[ m_g = m_g \sin \alpha + F_{\text{max}} \]

Accelerate up hill.

Situation 2 : just about to accelerate

\[ T + F_{\text{max}} - m_g \sin \alpha = 0 \]

\[ m_g = m_g \sin \alpha - F_{\text{max}} \]

Situation 3 : Neither 1 nor 2.

\[ a = 0 \]

No movement.

Example:

\[ m_1 = 1 \quad m_2 = 2. \quad \alpha = 30 \]

\[ m_3 = 0.5 \quad \mu_k = 0.4 \]

\[ m_g = 20 \quad m_g \sin \alpha = 5 \]

\[ F_{\text{max}} \mu_s = 4.33 \]

Condition 1:

\[ 20 > 5 + 4.33 \]

Uphill acceleration & String Tension
\[ F_{\text{max}} = \mu_k m g \cos \alpha \]

**Newton's 2nd Law** in direction:

\[ T - m_1 g \sin \alpha - \mu_k m_1 g \cos \alpha = m_1 a \]

2 unknowns: \( T \) and \( \alpha \).

Tension acceleration downwards

Tension = moving down, reduce.

Object 2:

\[ M_2 g - T = M_2 a \]

Thus 2 equations: 2 unknowns

\[ a = +3.85 \text{ m/s}^2 \]

\[ T = 12.3 \text{ KN} \]

Mandatory: that acceleration \( +ve \).

\( T \) tension < 20

\( +ve \) must reduce tension.

**Ex 2.**

\[ m_n = 0.4 \text{ kg} \quad m_1 = 1 \quad M_2 g = 4 \]

\[ 4 > 5 \Rightarrow 4.33 \quad \times \text{ not} \]

2nd case:

\[ 4 < 5 - 4.33 \quad \times \text{ no} \]

No acceleration, \( a = 0 \).
Demonstrations

1. Box. $361.79 \text{g}$.
   - Measure angle $\alpha = 20^\circ$

2. Box. Rope with a pulley.
   - Same number may be not - grown.

Set angle $20^\circ$.

\[
\begin{align*}
M_1 &= 100\text{g} \\
M_2 &= 170\text{g} + 25\text{g} \\
\end{align*}
\]

Frictional force changes direction.

Hydroplane example
Pan example - no friction (pin and ring lid)

Reduction of friction
Avoid contact
Lubricant (water)
Air hovercrafts
Airtrack
- object float
  blow out
  demonstration

Container of carbon dioxide
- 2D video
  gas film reduces friction
  Flea circus example
  small force to get in motion

http://