Friction Notes

Overview

Friction!

http://www.maniacworld.com/ducks-landing-on-ice.html

OK… so what is it?

Friction Description

- **Definition**
  - ***A force that opposes motion***
- When a force is applied to a body resting on a rough plane so that the body moves or tends to move, a frictional force acts on the body in opposition to the applied force.

Friction

- Symbol
  - F_f
- Units
  - Newtons (it's a force!)
- Depends on
  - Weight of object (normal force)
  - Nature of the surfaces between the moving object and the supporting surface

Friction

- Two types
  - Static friction (*pushing the piano but no motion*)
  - Sliding (kinetic) friction (*piano moves!!!*)
- Static force > kinetic force

Friction

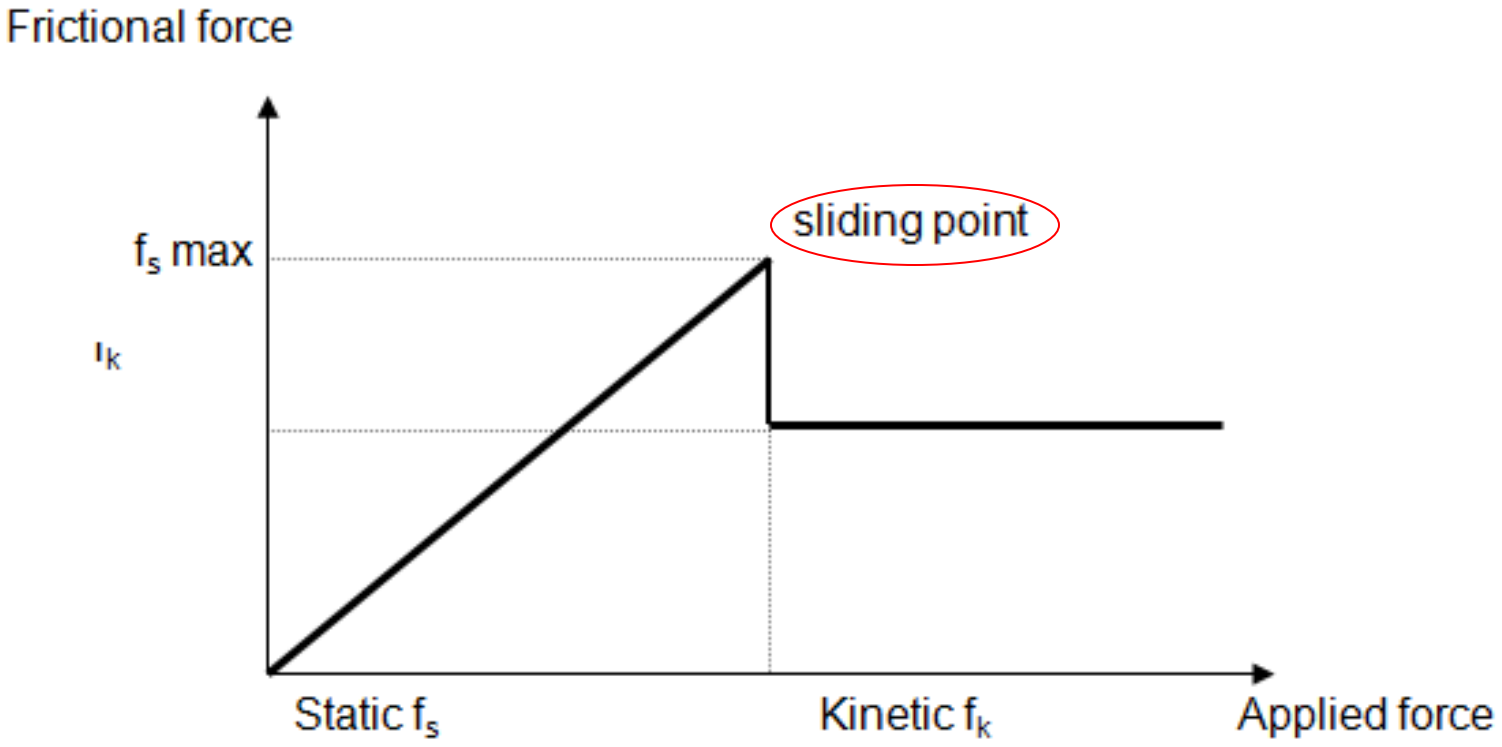
- Formula
  - $\mu = \frac{F_f}{F_N}$ or $F_f = \mu F_N$ where
    - μ = coefficient of friction,
    - values usually between 0 and 1
  - Note:
    - Low μ = slippery
    - High μ = sticky
    - F_N = normal force dependent on weight vector

Examples of μ

Surfaces	Static	Sliding
Hardwood on hardwood	0.5	0.25
Rubber on dry concrete	1.0	0.75
Rubber on wet concrete	0.75	0.5
Steel on steel	0.74	0.6
Steel on steel (lub'd)	0.15	0.06
Human joints	0.01	0.003

Stages of Friction

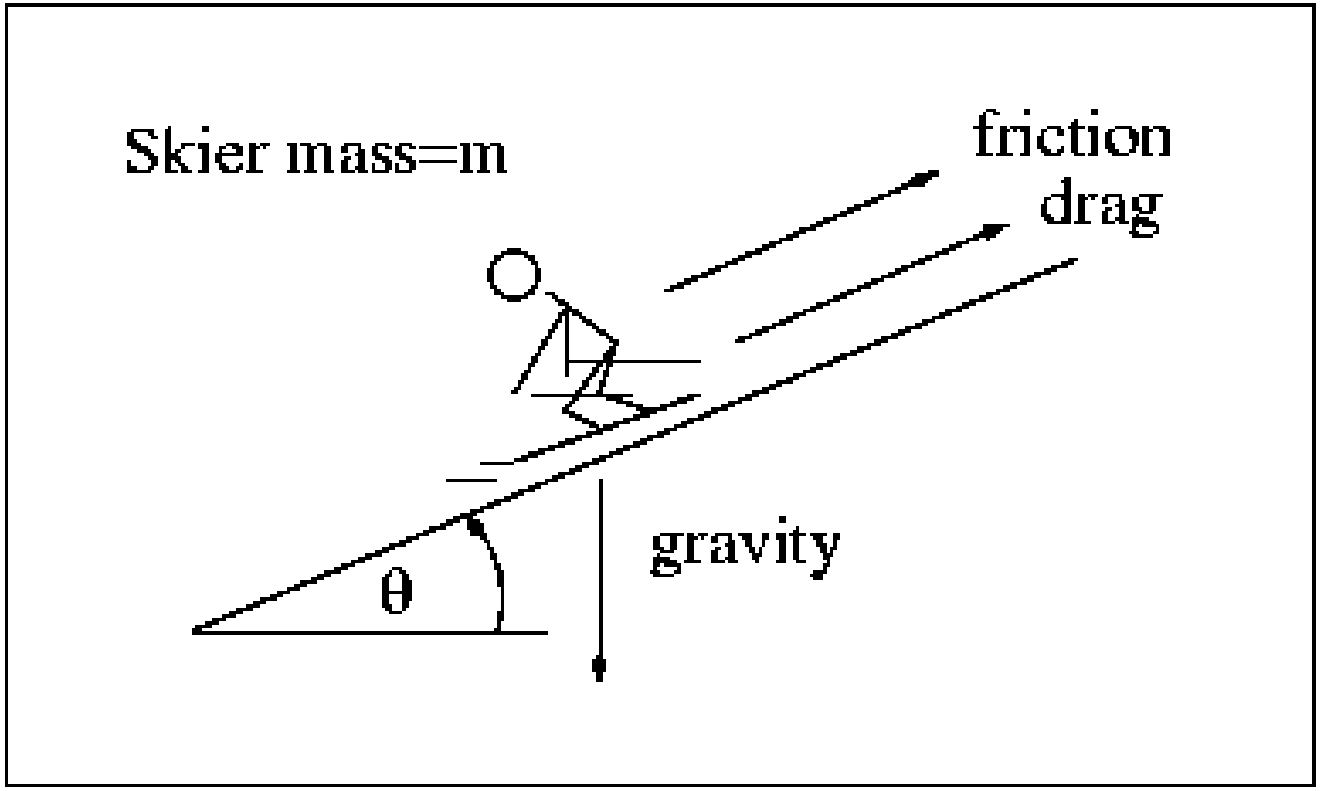
- Plot of applied force vs friction force



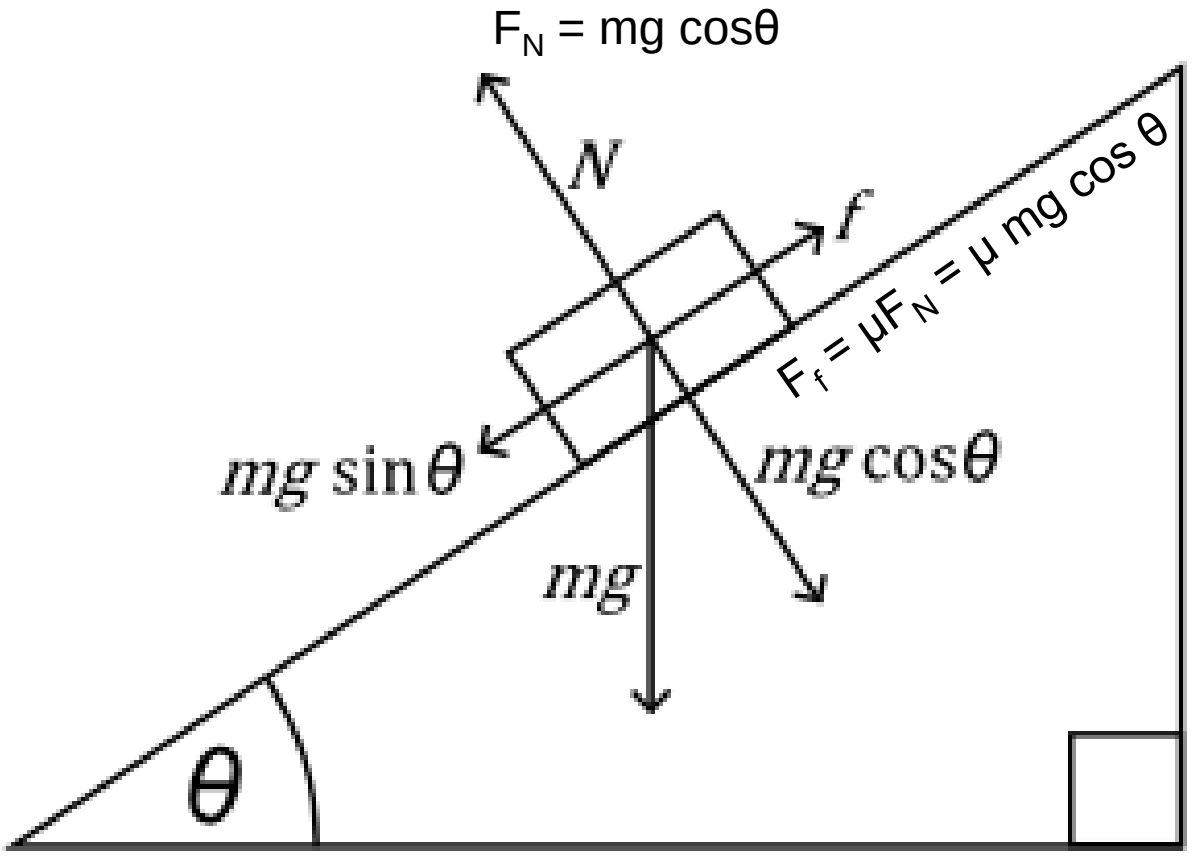
Friction Practice

- If it takes 200N to move a 100 kg box across a flat floor at **constant** speed, what is the coefficient of friction (μ)?
- Solution
  - **Constant** speed means no acceleration, so the applied force is balancing the friction force or a state of equilibrium exists $\therefore F_a = F_f$
  - $\mu = F_f/F_n = F_a/mg$
  - $= 200/(100 * 9.8) = \sim 0.2$

Inclined Plane with Friction



Friction on Inclined Plane

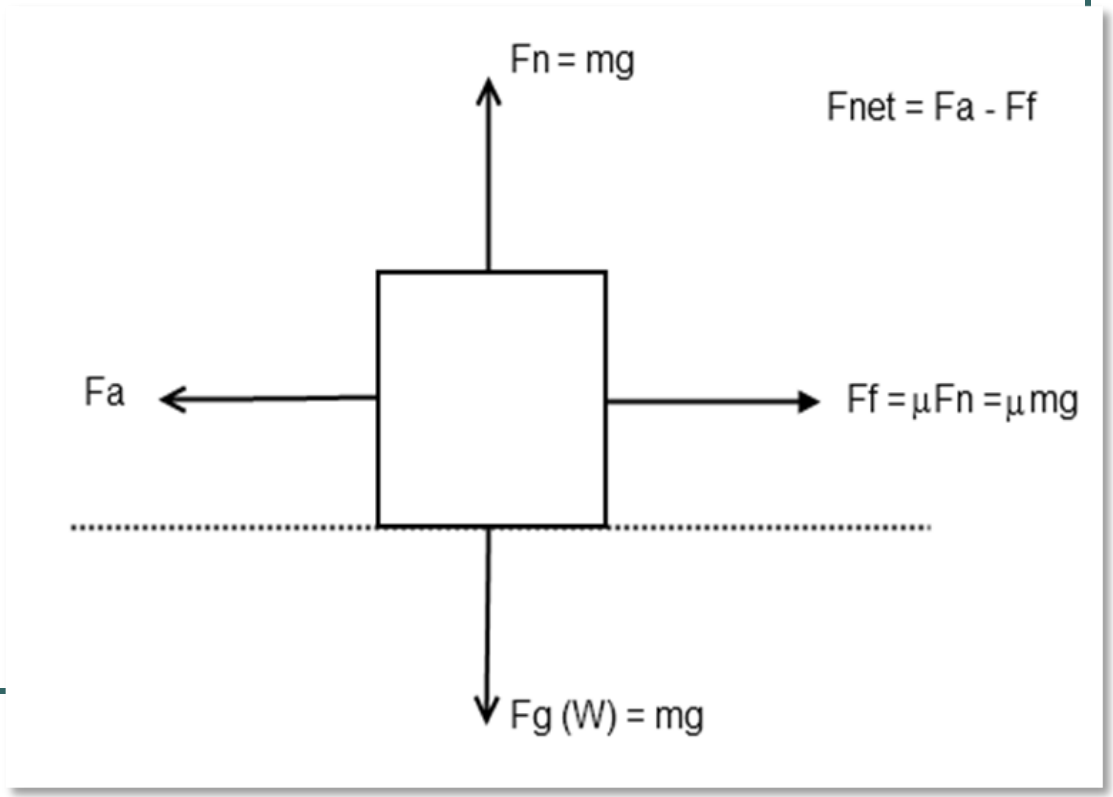


Practice Inclined plane

- What is the force of friction (F_f) between a 105 kg crate on a plane inclined at 30˚, with a coefficient of friction of 0.3?
- Solution
  - Use inclined plane diagram to find
    - F_f
    - $F_{||}$
    - F_{net}
    - a

Summary – Newton's 2nd Law: $F_{net} = ma$

- **Flat** plane
  - $a = F_{net}/mass$
  - $a = (F_a - F_f)/m$
  - $a = (F_a - \mu.F_n)/m$
  - $a = (F_a - \mu.mg)/m$



Summary – Newton's 2nd Law: $F_{net} = ma$

- **Inclined** plane
  - $a = F_{net}/mass$
  - $a = (F_{||} - F_f)/m$