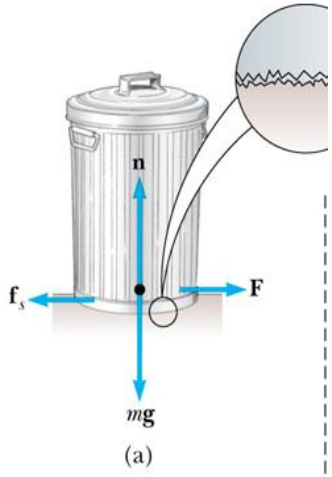
Frictional Forces

- Depends on the surfaces in contact
- Depends on /Proportional to the Normal Reaction, N
- Independent of the area of contact
- Object at rest: Static friction
- Object in motion: Kinetic friction

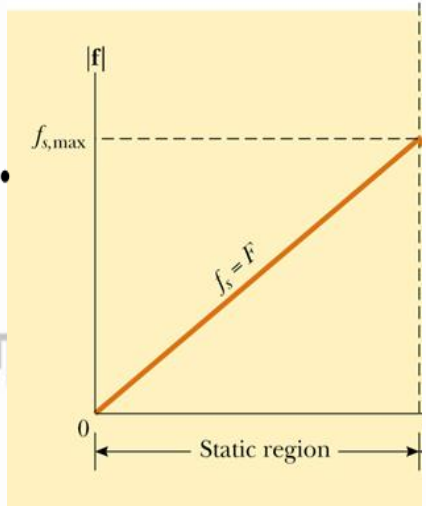
- Static Friction , f_s

  A horizontal force F is applied to a body placed on a ho. Surface. When F is small, it does not move. Even when F is increased, the body may still not move, showing that the frictional force has also increased. But at a certain value of F, the body just stats sliding.This shows that the Frictional force cannot increased beyond a certain value. This is called the max force of Static Friction Fs
  or Limiting friction

$$f_s \leq \mu_s N$$



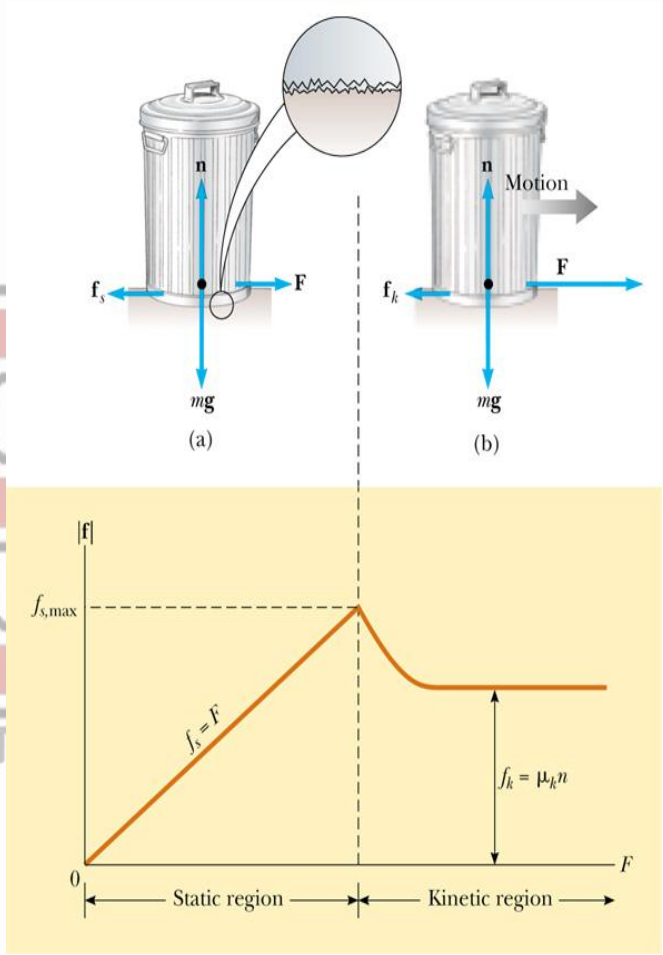
- Just enough force to keep object at rest.
- μ_s is coefficient of static friction
- N is the normal force



Kinetic Friction, f_k

$$f_k = \mu_k N$$

- μ_k is coefficient of kinetic friction
- Friction force opposes direction of motion
- *N* is the normal force



Coefficients of Friction

$$f \leq \mu_s N$$

$$f = \mu_k N$$

$$\mu_s > \mu_k$$

TABLE 4.2 Coefficients of Friction[a]

	μ_s	μ_k
Steel on steel	0.74	0.57
Aluminum on steel	0.61	0.47
Copper on steel	0.53	0.36
Rubber on concrete	1.0	0.8
Wood on wood	0.25–0.5	0.2
Glass on glass	0.94	0.4
Waxed wood on wet snow	0.14	0.1
Waxed wood on dry snow	—	0.04
Metal on metal (lubricated)	0.15	0.06
Ice on ice	0.1	0.03
Teflon on Teflon	0.04	0.04
Synovial joints in humans	0.01	0.003

[a] All values are approximate.

Example 6

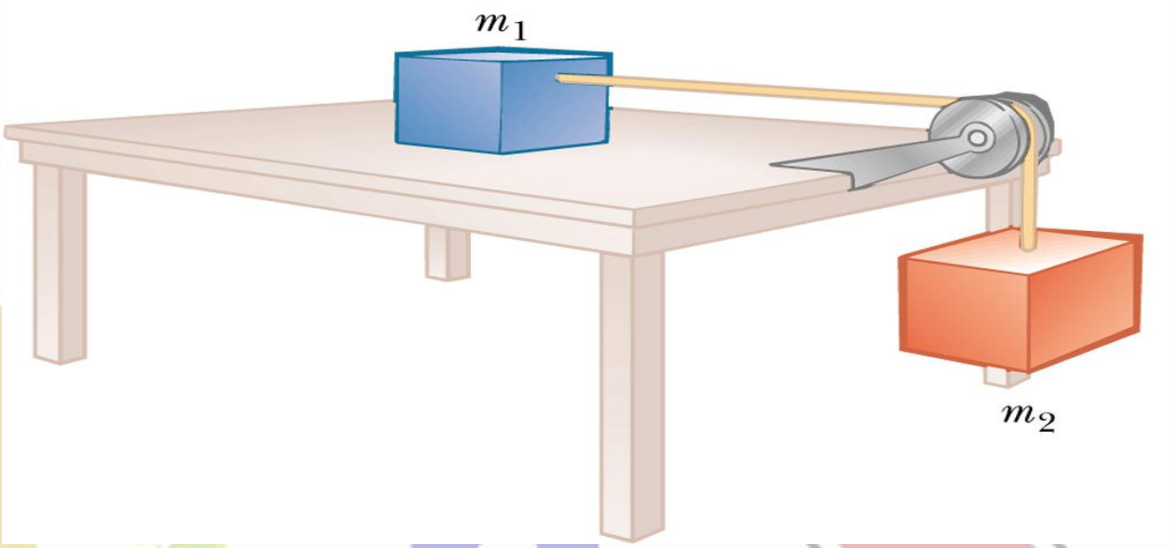
The man pushes/pulls with a force of 200 N. The child and sled combo has a mass of 30 kg and the coefficient of kinetic friction is 0.15. For each case:

What is the frictional force opposing his efforts?

What is the acceleration of the child?

f=59 N, a=3.80 m/s^2 / f=29.1 N, a=4.8 m/s^2

Example 7



Given m_1 = 10 kg and m_2 = 5 kg:

a) What value of μ_s would stop the block from sliding?

b) If the box is sliding and μ_k = 0.2, what is the acceleration?

c) What is the tension of the rope?

a) μ_s = 0.5 b) a=1.96 m/s^2 c) 39.25 N

Example 8

What is the minimum μ_s required to prevent a sled from slipping down a hill of slope 30 degrees?

$\mu_s = 0.577$