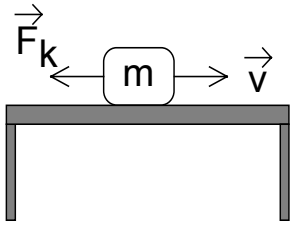
LECTURE #14 – SUMMARY

Section III.5 Friction

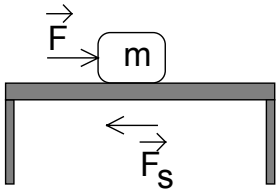
Definition: a force that acts between two surfaces to oppose their relative motion.

Kinetic Friction ($\vec{F}_k$)



- acts between two surfaces that are in relative motion
- associated with motion
- caused by microscopic bonds that continually form and break as surfaces slide past each other
- always acts opposite to the direction of the velocity, and always tends to act to slow down the speed of the object
- does not necessarily act opposite to the direction of the net force parallel to the boundary because
  (1) There may not be any forces parallel to the boundary other than friction.
  (2) Even if there are other forces, they may be in the same direction as $\vec{F}_k$.

Static Friction ($\vec{F}_s$)



- acts between two surfaces at rest relative to each other.
- more microscopic bonds have time to form, so a greater force is needed to initiate motion
- magnitude must be variable and have a maximum value. While the object is at rest, by Newton's Second Law, we have $F = F_s$ so that as F increases, so does F_s !
- maximum magnitude must be larger than the kinetic friction for a particular pair of materials because there is more time for bonds to form between surfaces
- acts opposite to the direction of the applied force

Magnitude of Frictional Forces (determined experimentally)

Leonardo da Vinci observed that static and kinetic friction are

- independent of the "macroscopic" contact area
- proportional to the magnitude of the normal force exerted on the object

Kinetic friction: $\boxed{F_k = \mu_k N}$, opposite to velocity of object and perpendicular to $\vec{N}$

where N = normal force acting on the object (between the two surfaces)

μ_k = coefficient of kinetic friction (depends on properties of the surfaces)

Static friction: $\boxed{0 \le F_s \le \mu_s N}$, opposite to direction of the net applied force

where μ_s = coefficient of static friction

$\mu_s > \mu_k$ because bonds between stationary surfaces are harder to break

Note: μ_k, μ_s are dimensionless and vary from ~0.01 (smooth) to 1.5 (rough).