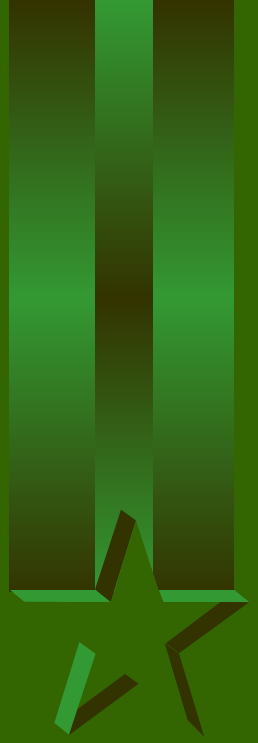


Chapter 4-4

Weight, Force, and Friction

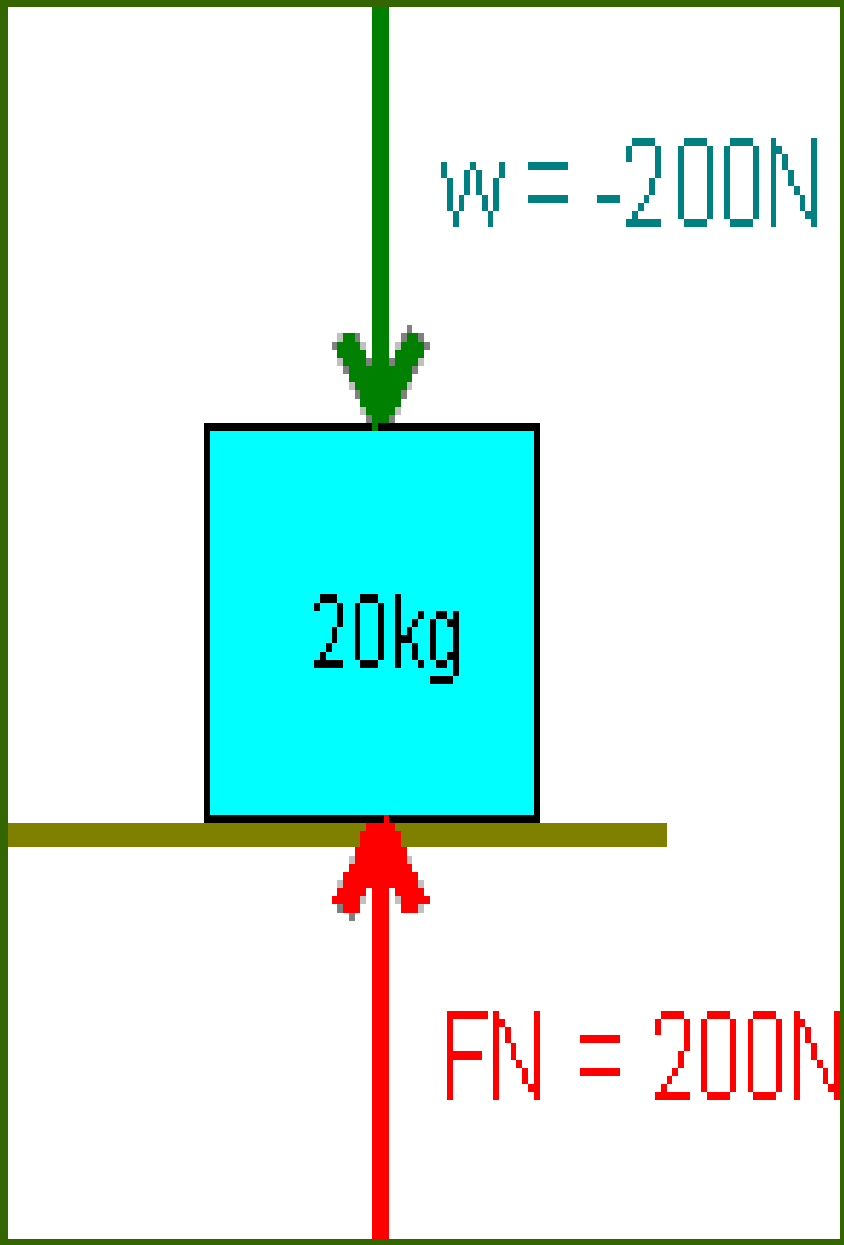
Weight

- Weight is the magnitude of the force of gravity acting on an object.
- Weight = Fg
- Fg = mass x gravity

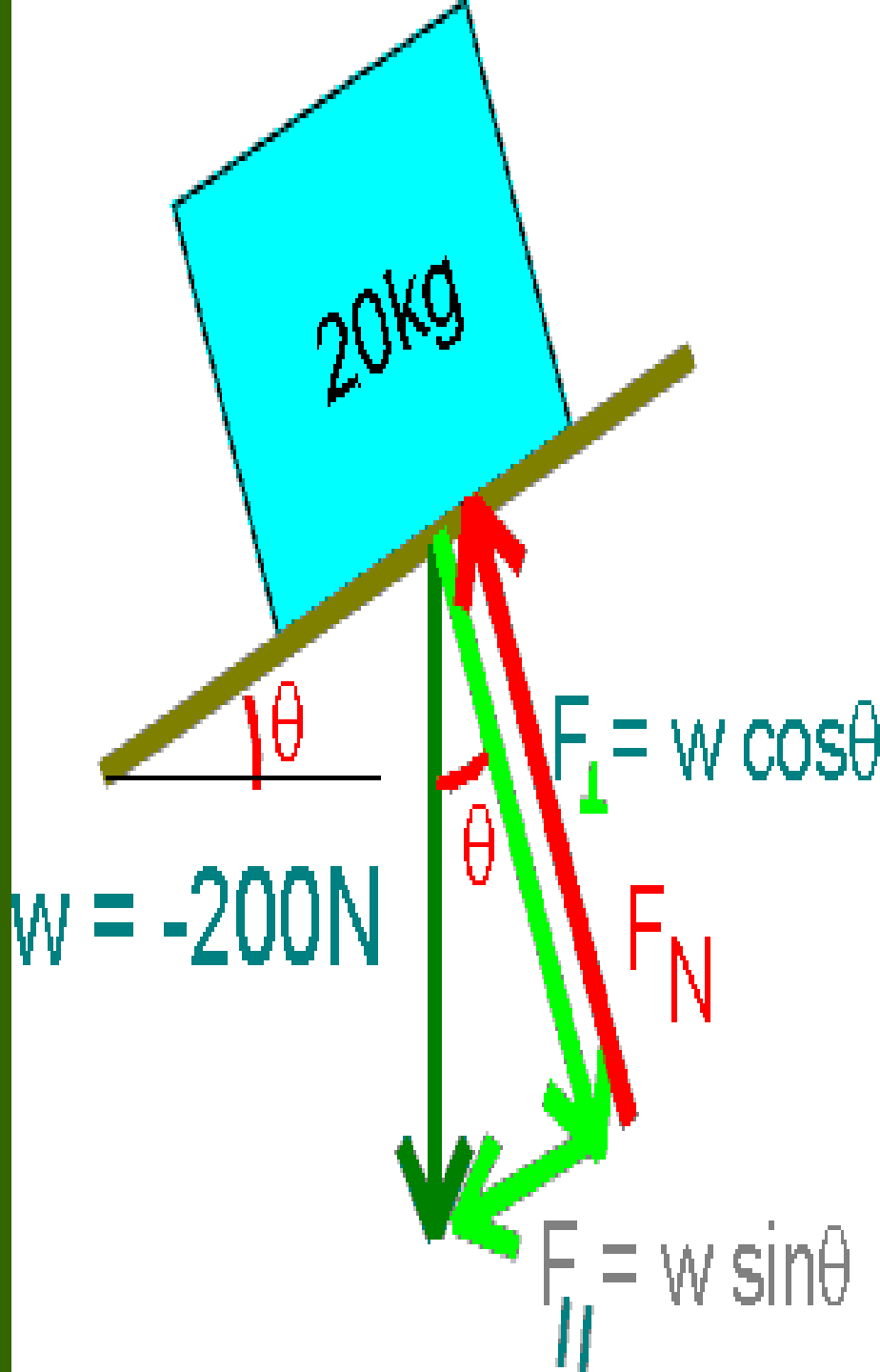
Normal Force

- Normal Force is a force exerted by one object on another in a direction perpendicular to the surface of contact.

- The normal force is always perpendicular to the surface but is not always opposite the force of gravity.



- On an angle, the normal force is calculated using $F_n = mg\cos\theta$. The θ is the angle of the ramp.



Friction

- Friction opposes the applied force.
- Two types of friction: Static and Kinetic

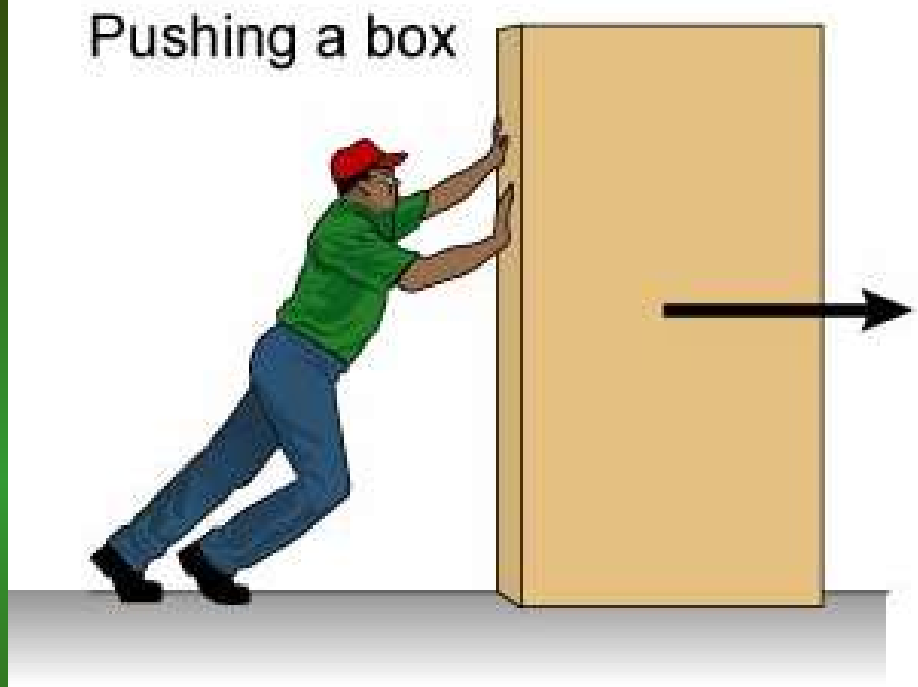
Static Friction

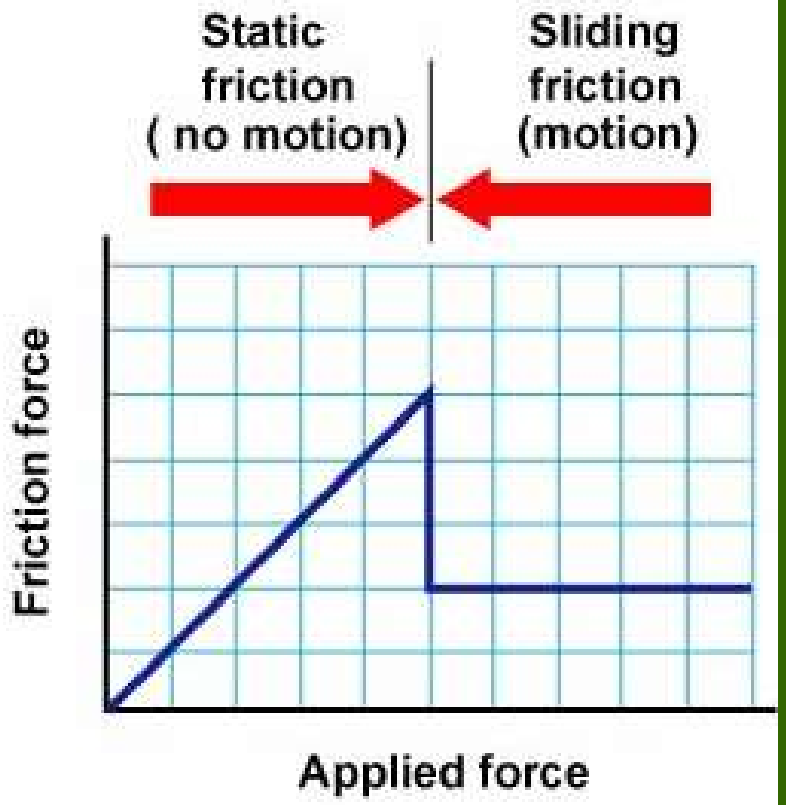
- The resistive force that keeps objects from moving is called the force of static friction.
- Static Friction = F_s
- As long as the object doesn't move, the static friction is always equal to the opposite in direction to the applied force.
- $Fs = -F_{applied}$
- When the applied force is as great as it can be without moving the object, the force of static friction reaches its maximum value, called F_{smax}

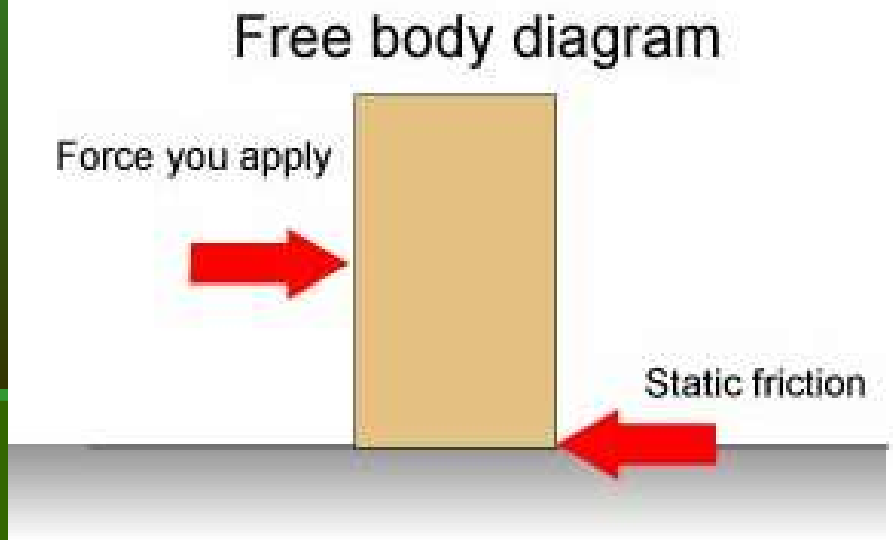
Kinetic Friction

- Once an object exceeds F_{smax}, it begins to move.
- The resistive force that opposes the relative motion of two contacting surfaces that are moving is called the force of kinetic friction (F_k)

Friction Forces







- The force of friction is proportional to the normal force.
- It is easier to push a chair across the floor at a constant speed than to push a heavy desk across the floor at the same speed.
- Because the desk is heavier than the chair, the desk experiences a greater normal force and therefore greater friction.

Coefficients of Friction

- Friction depends on the surfaces in contact.
- The quantity that expresses the dependence on frictional forces on the particular surfaces in contact is called the coefficient of friction.
- Coefficient of friction is represented by the symbol μ and pronounces mu.

Coefficient of kinetic friction

- $\mu_k = F_k/F_n$
- Divide the Force of kinetic friction by the normal force

Coefficient of static friction

- $\mu_s = F_{smax} / F_n$
- Divide the maximum value of static friction by the normal force

- If the value of μ is known and the normal force is known, then the magnitude of the force of friction can be calculated.
- $F_f = \mu F_n$

- The kinetic friction is always less than or equal to the maximum static friction.
- Think about pushing a car that is sitting still or pushing a car that is already moving.
- The coefficient of kinetic friction is always less than or equal to the coefficient of static friction.

Materials	μ_s	μ_k
Wood on wood	0.5	0.3
Waxed ski on snow	0.1	0.05
Ice on ice	0.1	0.03
Rubber on concrete (dry)	1.0	0.8
Rubber on concrete (wet)	0.7	0.5
Glass on glass	0.94	0.4
Steel on aluminum	0.61	0.47
Steel on steel (dry)	0.7	0.6
Steel on steel (lubricated)	0.12	0.07
Teflon on steel	0.04	0.04
Teflon on Teflon	0.04	0.04
Synovial joints (in humans)	0.01	0.01

Air Resistance

- Whenever an object moves through a fluid medium, like air or water, the fluid provides a resistance to the motion.
- When an object falls through the air, its velocity increases until the air resistance balances the downward force of gravity.
- The object falls with a constant speed, called terminal speed.

Sample Problem 4C

- A 24 Kg crate initially at rest on a horizontal floor requires a 75 N horizontal force to set it into motion. Find the coefficient of static friction.
- Knowns?
- Unknown?
- Equations?
- Answer