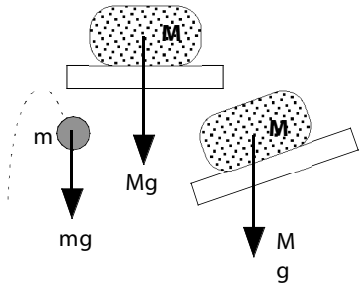
PhyzGuide: Meet The Forces!

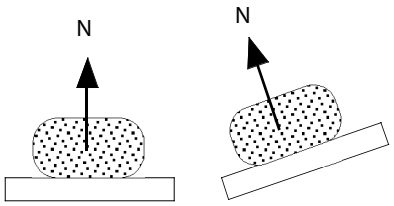
WEIGHT

Weight is an interaction between any two objects with mass. Weight acts between all objects on earth, regardless of their motion. The weight of an object on the earth acts toward the center of the earth—straight down. The weight of an object depends on its mass and acceleration due to gravity: $W = mg$.



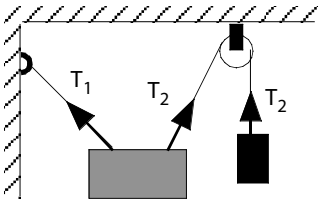
NORMAL

This force represents any compression of any two surfaces against each other. A book resting on a table is prevented from falling to the ground (due to its weight) because the table exerts an upward normal force on the book. The **normal force** exerted by a surface is always perpendicular to that surface. The normal force is sometimes—*but certainly not always*—equal in magnitude and opposite in direction to weight. When an object lies on a level, non-accelerating surface, $N = W$. But if the surface is not level or if it is accelerating vertically, $N \neq W$. The normal force is *never* a Newton's third law force pair to weight.



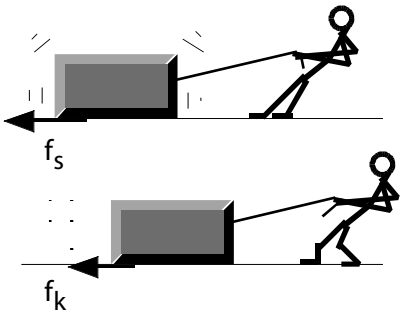
TENSION

When a force is transmitted through a string, rope, or wire, etc., the force is called **tension**. Tension tends to stretch the string and will break the string if it becomes too great. The tension in a string is constant throughout the string. There is no direct equation for tension.



FRICTION

Friction arises when an object is being "urged" to slide across a surface or when an object actually is sliding across a surface. If the object isn't moving, the static friction force can take on *any* value *up to* $f_s = \mu_s N$. If the object is sliding, the kinetic friction force is constant at $f_k = \mu_k N$. The coefficients of friction μ_s and μ_k are unitless numbers that depend on the surface characteristics of the surfaces in contact. The normal force N was discussed above.



DRAG

Whenever a fluid encounters a solid object (or *vice versa*), the force of **drag** appears. It could be that the solid object is moving through a fluid or that a fluid is moving past a stationary solid object. For example, a car moving along the highway is pushed back by the air it runs into. Drag is significant (to us) when speed of the object relative to the fluid is relatively high. At these speeds, the resistance is proportional to the square of the speed: $D = kv^2$. The aerodynamic coefficient k depends on the shape and cross-sectional area of the object as well as the density of the fluid.

OTHER FORCES

There are, of course, other forces that act throughout the universe, but those listed above are the common mechanical forces. Please note that weight, tension, friction, etc., are simply the *names* of forces. We have not yet discussed the underlying *nature* of any of these forces.