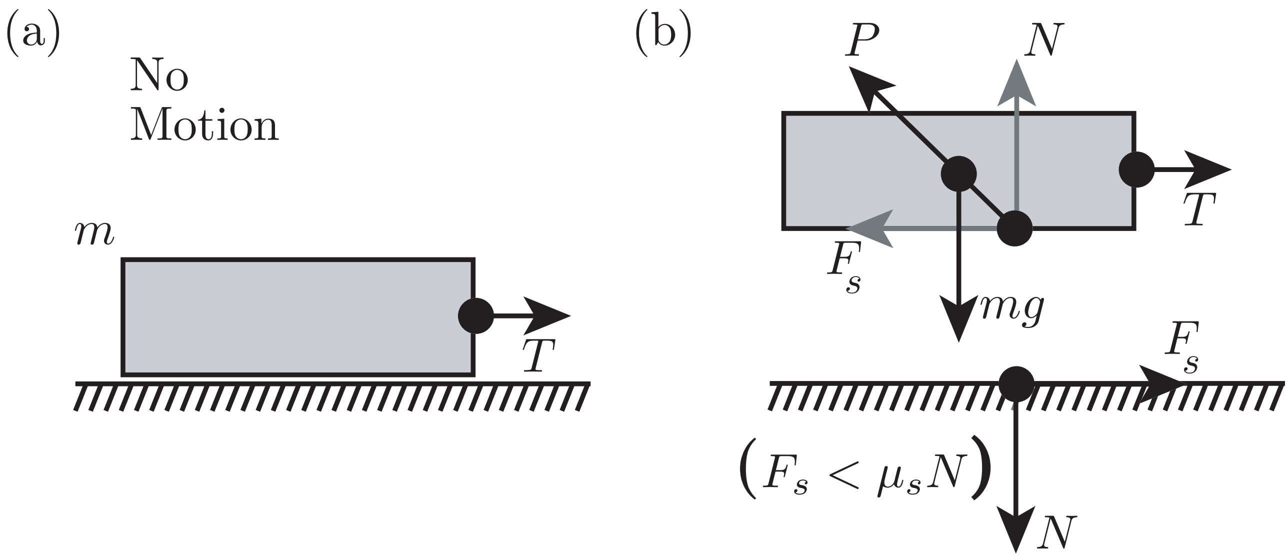
5. Forces (2)

Friction:

The force which prevents, or tries to prevent, the slipping or sliding of two surfaces in contact is called **friction**. When the surface of one body slides over another, each body exerts a frictional force on the other, parallel to the surfaces. The frictional force on each body is opposite to the direction of its motion. Frictional forces may also act when there is no relative motion, as shown.



A cord is attached to a block of weight $\underline{W} = m\underline{g}$ and the tension, $\underline{T}$, in the cord is such that the block remains at rest (diagram (a)). Diagram (b) is the corresponding separated body diagram. $\underline{P}$ is the force exerted on the block by the surface. $\underline{N}$ and $\underline{F}_s$ are the components of $\underline{P}$, normal to and parallel to the surface. $\underline{F}_s$ is called the force of static friction.

From Newton's 2nd law,

$$\underline{N} = -\underline{W} \quad \text{and} \quad \underline{F}_s = -\underline{T}$$

with corresponding scalar forms

$$N = W \quad \text{and} \quad F_s = T$$

As $\underline{T}$ is increased, a limiting value is reached after which the block starts to move. Thus there is a certain maximum value which $\underline{F}_s$ can have. The magnitude of this maximum value depends on the normal force $\underline{N}$ and a useful empirical law is

$$F_s(\max) = \mu_s N$$

where μ_s is called the coefficient of static friction. The magnitude of the actual force of static friction can take any value between 0 and F_s(max). Thus

$$F_s \leq \mu_s N$$

As soon as sliding begins, the friction force decreases. This new friction force, $\underline{F}_k$, also depends on the normal force. The empirical law used is

$$F_k = \mu_k N$$

where μ_k is the coefficient of sliding (or kinetic) friction. The values of μ_s and μ_k depend on the nature of the two surfaces which are in contact.