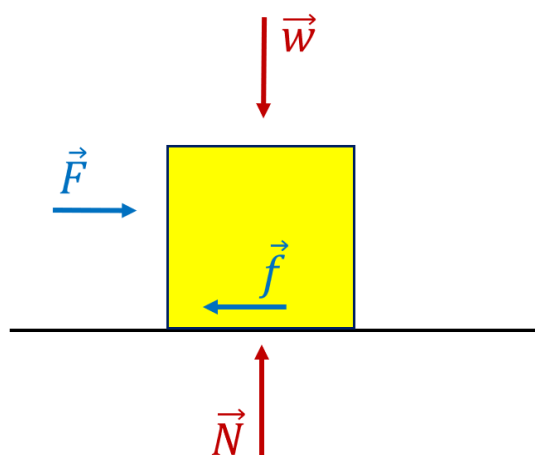


# Chapter 9. Friction

## Section 9.1. Theory of Dry Friction

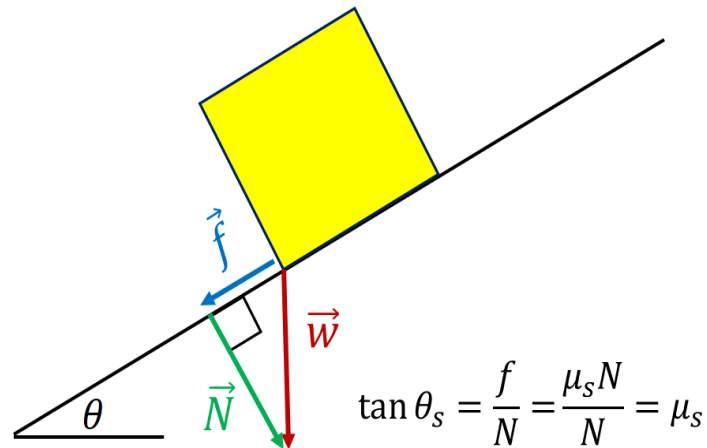
**Note.** If an object of weight  $w$  sits on a horizontal surface and a force  $\vec{F}$  is applied horizontally, then for small values of  $F$ , the object does not move due to frictional forces (this means there is a force  $\vec{f}$  due to friction which balances  $\vec{F}$ ).



**Note.** In the “theory of dry friction” (or Coulomb friction) we assume that the force  $f$  above can be as large as  $f = \mu_s N$  where  $N$  is the normal component of the contact force ( $N = w$  if the surface is horizontal) and  $\mu_s$  is the *coefficient of static friction*.

**Note.** If an object is moving, then the force due to friction is  $f = \mu_k N$  where  $\mu_k$  is the *coefficient of kinetic friction*.

**Note.** If a mass sits on a ramp making angle  $\theta$  with the horizontal, then a mass of weight  $w$  will *start* to slide if  $\tan \theta = \mu_s$ . The value of  $\theta$  for which  $\theta_s = \tan^{-1}(\mu_s)$  is the *angle of static friction*. Similarly, the *angle of kinetic friction* is  $\theta_k = \tan^{-1}(\mu_k)$ .



**Examples.** Page 446 Example 9.2. Page 457 Number 9.57.

*Revised: 9/26/2018*