3.5 Friction

There are two types of friction. Both always oppose motion. On the microscopic level, irregularities in the two surfaces catch on one another.

Kinetic friction is the force exerted on one surface by another when the two surfaces slide against each other. It is called kinetic since movement is involved.

Imagine you are trying to push your couch across the floor. Static friction is the balancing force acting against you that keeps the couch from sliding. It is always equal to your input force as long as the couch does not move. It acts in response to other forces.

Friction is given by the equation:

$\vec{F}_f = \mu \vec{F}_n$

Where $\vec{F}_n$ = Normal Force
= always perpendicular to surface

and μ = coefficient of friction (no units)
= greek lettre "mu"
= depends on both surfaces

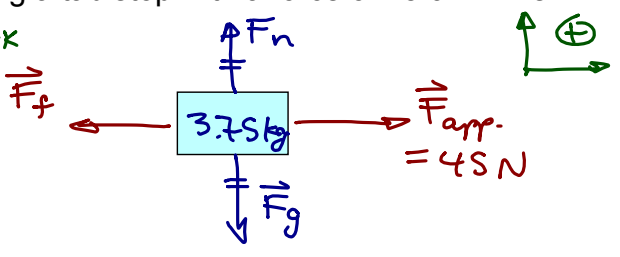
$\vec{F}_{static} > \vec{F}_{kinetic}$

$\mu_{static} > \mu_{kinetic}$

ex. A 3.75 kg block is pushed along a tabletop with a force of 45.0 N. The coefficient of friction is 0.65 $= \mu_k$

a) Find the force of Friction

b) Find the acceleration



a) $\vec{F}_f = \mu \vec{F}_n$

$\vec{F}_{net_y} = 0$

$\therefore \vec{F}_g = \vec{F}_n$

$m\vec{a} = \vec{F}_n$

$\vec{F}_n = (3.75)(9.8)$

$= 36.75$ N

$\therefore \vec{F}_f = (0.65)(36.75)$

$\vec{F}_f = 23.89$ N

$\boxed{\vec{F}_f = 24 \text{ N}}$

b) $\vec{F}_{net_x} = 45\text{N} - 23.89\text{N}$

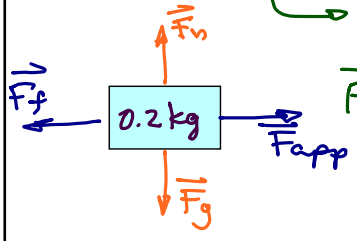
$\vec{a}_x = \dfrac{\vec{F}_{net_x}}{m}$

$= \dfrac{45\text{N} - 23.89\text{N}}{3.75\text{ kg}}$

$\boxed{\vec{a}_x = 5.6 \text{ m/s}^2 \text{ [right]}}$

ex. A 0.200 kg puck is pushed along a sheet of ice with a force of 0.240 N. If it moves at a constant velocity, find the coefficient of friction.

$\vec{F}_{net_x} = 0 \Rightarrow \vec{F}_{app.} = \vec{F}_f$



$\vec{F}_{app} = \vec{F}_f = 0.240\ N$

$\mu = \frac{\vec{F}_f}{\vec{F}_n} \Rightarrow \vec{F}_n = \vec{F}_g$

$= (0.2\ kg)(9.8\ m/s^2)$

$\vec{F}_n = 1.96\ N$

$\therefore \mu_k = \frac{0.240\ N}{1.96\ N}$

$\mu_k = 0.122$

ex. A 1.10 kg textbook is held against a vertical wall with a force of 45.0 N.

a) What is the coefficient of friction between the book and the wall?

b) If there is also an upward force of 25.0 N, what is its acceleration?

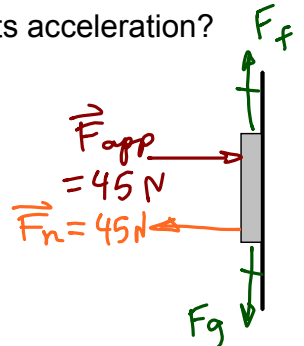
a) given: $m = 1.1\ kg$

$\vec{F}_{app} = 45\ N$

$F_f = F_g = (1.1\ kg)(9.8\ m/s^2)$

$= 10.78\ N$

$\mu = \frac{F_f}{F_n} = \frac{10.78\ N}{45\ N} = 0.240$



b) $\vec{F}_{net_y} = \vec{F}_{app.} - \vec{F}_f - \vec{F}_g$

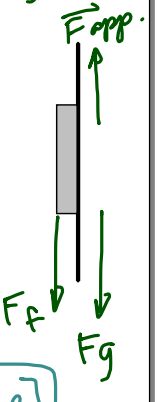
$= 25\ N - 10.78 - 10.78$

$= 3.44\ N$

$\vec{a}_y = \frac{\vec{F}_{net_y}}{m}$

$= \frac{3.44\ N}{1.10\ kg}$

$\vec{a} = 3.13\ m/s^2\ [up]$



practice: Worksheet 5.3 Force of Friction