Friction

Friction is created whenever objects are in contact

On the microscopic level bumps in objects run together

Friction is given by the equation $F_{fric} = \mu F_N$

Where F_N = Normal Force μ = coefficient of friction

Static friction is the friction acting against starting motion

Kinetic friction is the friction acting against motion

Static Friction > Kinetic Friction

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

Example 1: A 3.75kg block is on a tabletop. The coefficient of static friction is 0.65, the coefficient of kinetic friction is 0.53.

What force is required to start the block moving?

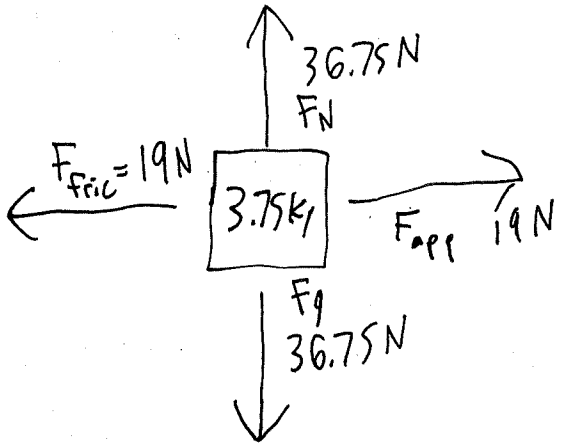
$F_N = F_g = mg = 3.75 \times 9.8 = 36.75N$

$F_{fric} = \mu F_N = 0.65 \times 36.75N = 24N$

Once it has started moving what force is required to keep it moving at a constant velocity?

$F_{fric} = \mu F_N = 0.53 \times 36.75N = 19N$

Draw a FBD of the block moving at a constant velocity with the magnitudes of all forces labelled.



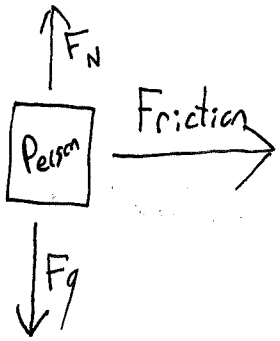
Example 2: A 0.200 kg puck is pushed along a sheet of ice by an applied force of 0.240 N. If it moves at a constant velocity find the coefficient of kinetic friction.

$$F_N = F_g = mg = 0.200\,kg \times 9.8\,\frac{m}{s^2} = 1.96\,N$$

$$F_{Fric} = F_{app} = 0.240\,N$$

$$F_{Fric} = \mu F_N \rightarrow \mu = \frac{F_{Fric}}{F_N} = \frac{0.240\,N}{1.96\,N} = 0.12$$

Example 3: What is the maximum acceleration a 45 kg person can do if the coefficient of friction between them and the ground is 0.34?



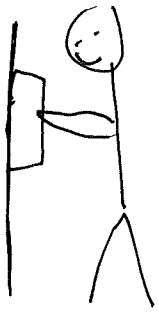
$$F_{fric} = \mu F_N = \mu F_g = \mu mg$$

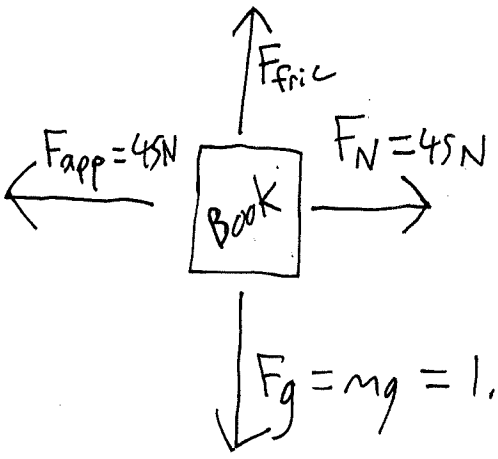
$$= 0.34 \times 45\,kg \times 9.8\,\frac{m}{s^2}$$

$$= 149.94\,N$$

$$F_{net} = ma \rightarrow a = \frac{F_{net}}{m} = \frac{149.94\,N}{45\,kg} = 3.3\,m/s^2$$

Example 4: A 1.1 kg textbook is held against a wall by an applied force of 45 N. What is the minimum coefficient of static friction between the wall and book?





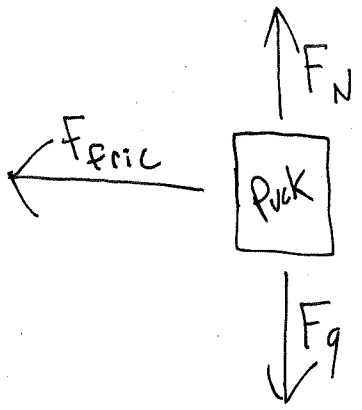
$$F_g = mg = 1.1kg \times 9.8\frac{m}{s^2}$$

$$= 10.78N$$

$$F_{fric} = \mu F_N$$

$$\mu = \frac{F_{fric}}{F_N} = \frac{10.78N}{45N} = 0.24$$

Example 5: A 0.200 kg puck with a coefficient of kinetic friction of 0.102 between it and the ice is shot a velocity of 26 m/s. How far will it travel before it stops?



$$F_{net} = F_{fric} = \mu F_N = \mu F_g = \mu mg = 0.102 \times 0.200 kg \times 9.8 m/s^2$$
$$= 0.19992 N$$
$$= 0.19992 N$$

$$F_{net} = ma \rightarrow a = \frac{F_{net}}{m} = \frac{0.19992}{0.200} = 0.9996 m/s^2$$

$V_f = 0$

$V_0 = 26 m/s$

$a = -0.9996 m/s^2$

$d = ?$

Use $v_f^2 = v_0^2 + 2ad$

$d = 340 m$