
# CLASS 15: FRICTION

# Quickuiz

A person pulls a box across the floor. Which is the correct analysis of the situation?

A. The box moves forward because the person pulls forward slightly harder on the box than the box pulls backward on the person.

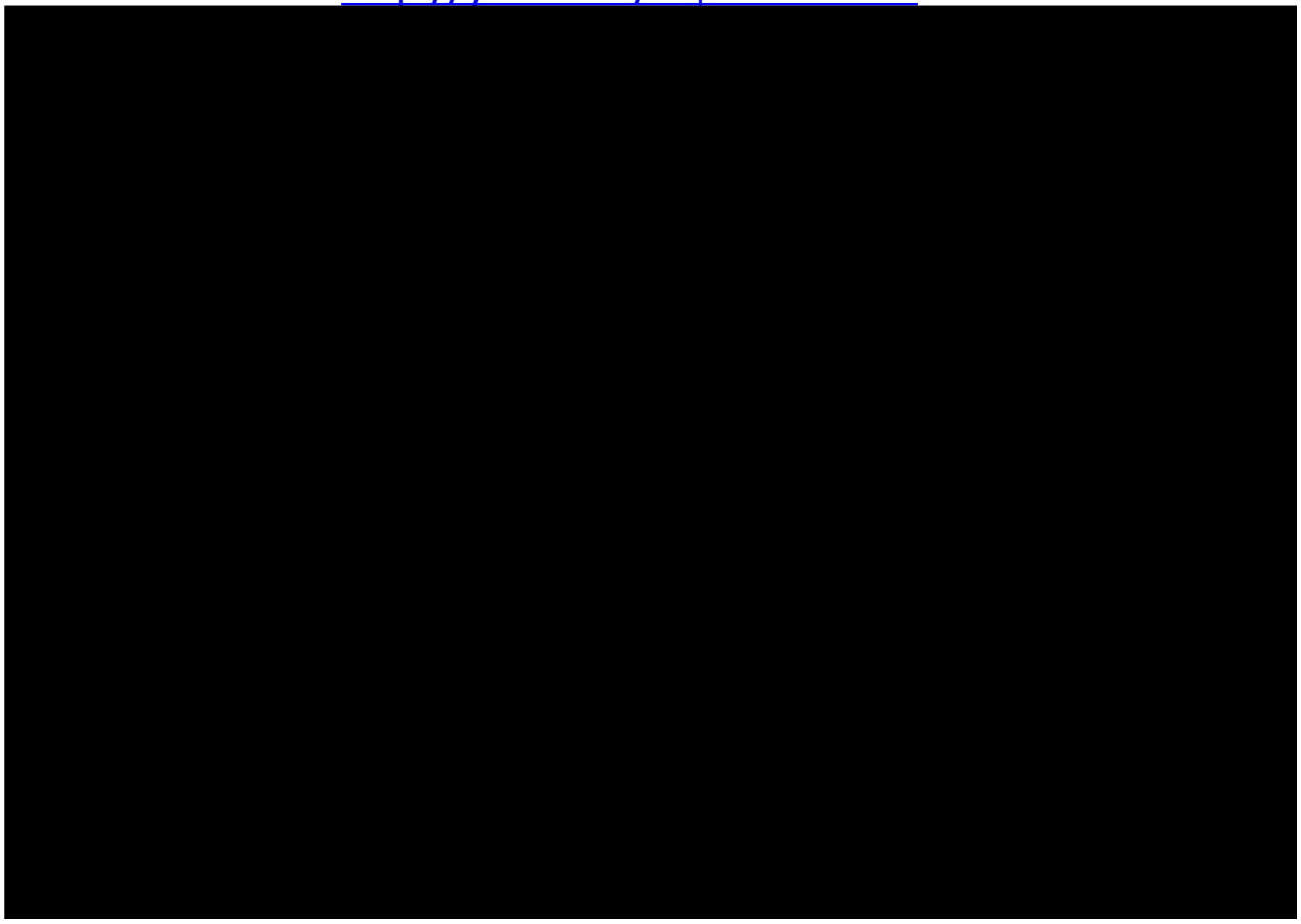
B. Because action always equals reaction, the person cannot pull the box- the box pulls backward just as hard as the person pulls forward, so there is no motion.

C. The person gets the box to move by giving it a tug during which the force on the box is momentarily greater than the force exerted by the box on the person.

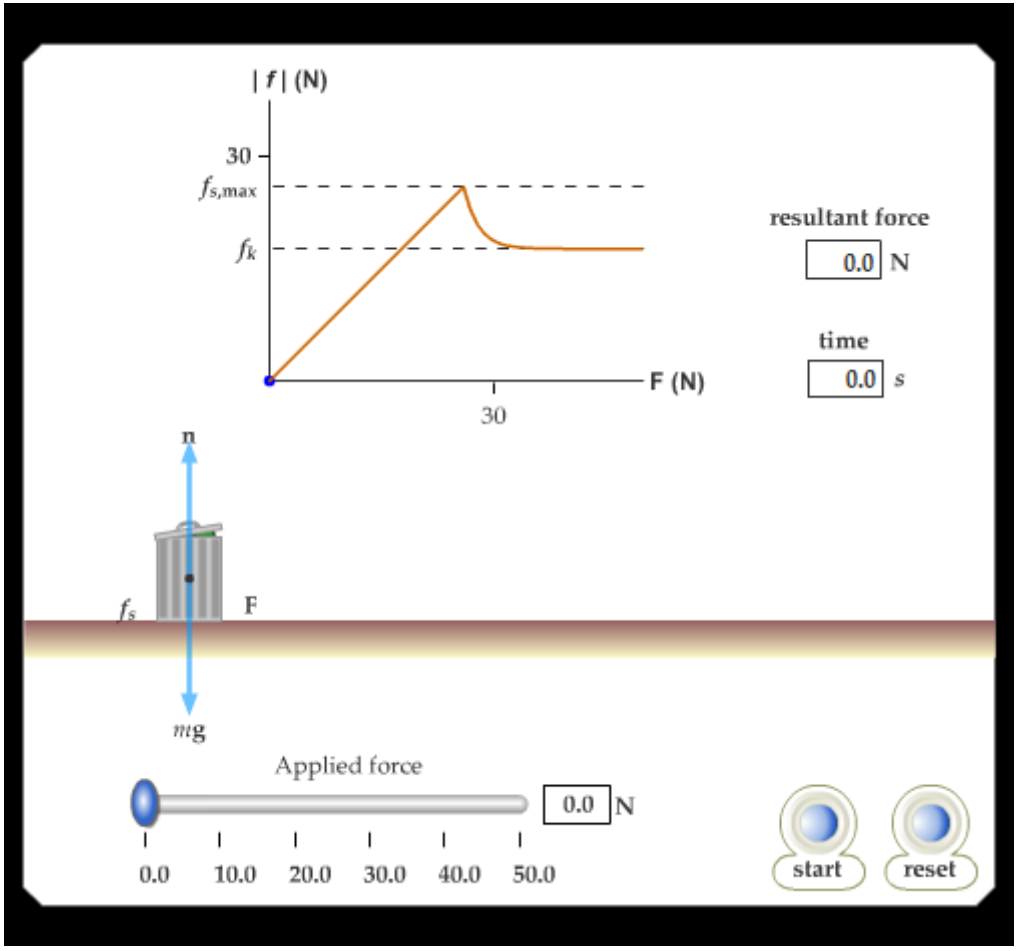
D. The person's force on the box is as strong as the force of the box on the person, but the frictional force on the person is forward and large while the backward frictional force on the box is small.

# World's Strongest Man

http://youtu.be/0xpuub2DBB8



# Static vs. Kinetic Friction



# Static vs. Kinetic Friction

- Static friction force $f_s$ acts to **prevent the object from moving**:

$$f_s \leq \mu_s N$$

- $\mu_s$ is called the coefficient of static friction
- While kinetic friction force $f_k$ **starts acting after** the object starts moving and opposes its motion:

$$f_k = \mu_k N$$

- Notice that the coefficient of kinetic friction $\mu_k$ is not necessarily equal to $\mu_s$.
- Notice also that these coefficients have **no units**.

# Static vs. Kinetic Friction

- Further exploration can be done using a PhET simulation called Force and Motion accessible here:

  http://phet.colorado.edu/en/simulation/forces-and-motion

# Quickuiz

A crate lying on a flat linoleum floor has a coefficient of static friction $\mu_s = 0.5$, coefficient of kinetic friction $\mu_k = 0.25$ and a mass of $40.0$ kg. What will the net horizontal force on the crate be if you push on it horizontally with a force of $+100.0$ N? Use $g = 10.0\ \mathrm{m/s^2}$ *(If the crate starts moving, give the net force after it has started moving.)*

A. $+100.0$ N

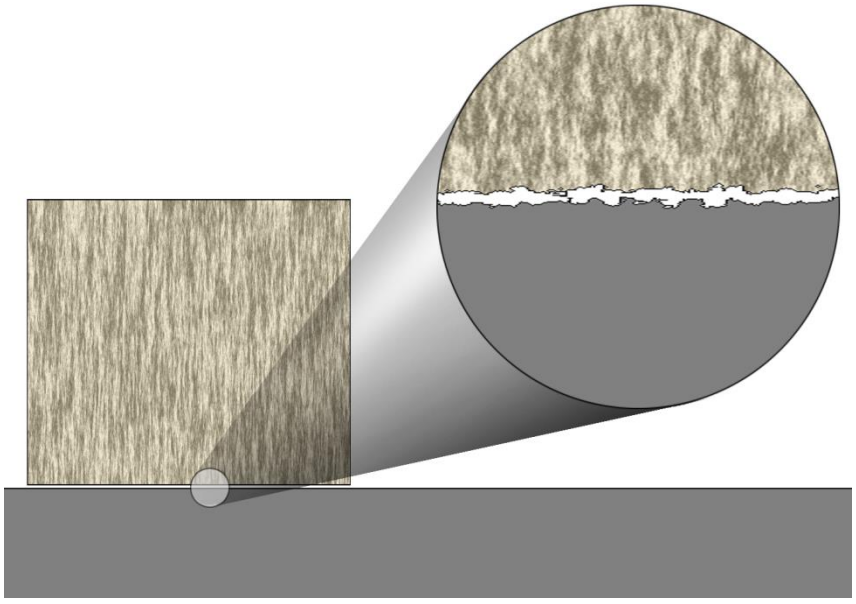
B. $-100.0$ N

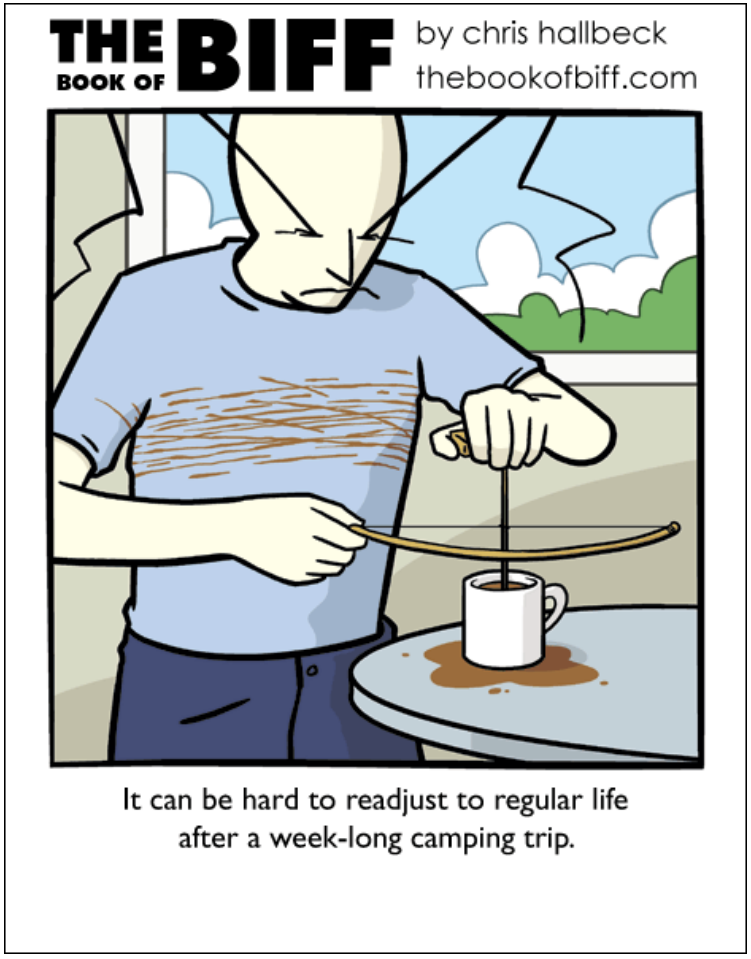
C. $0.0$ N

D. $+200.0$ N

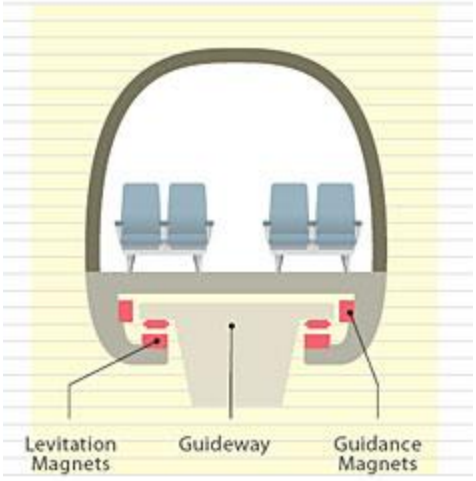
$$f_s \leq \mu_s N, \qquad f_k = \mu_k N$$
$$N = mg = 400.\mathrm{N}$$
$$f_s \leq 0.5 \times 400.\mathrm{N}$$
$$f_s \leq 200.\mathrm{N}$$
$$f_k = 0.25 \times 400. = 100.\mathrm{N}$$

# Friction is a Dissipative Force





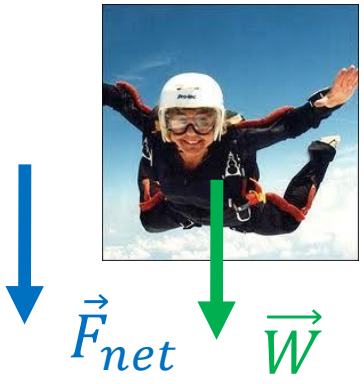
# Motion without Friction



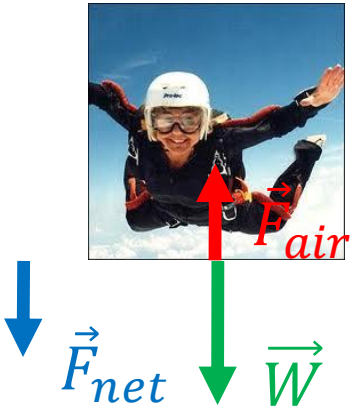
# Air Resistance

An object moving in a fluid (liquid or gas) will experience a drag force that will slow down its motion

The result is a terminal velocity reached when the net force is zero

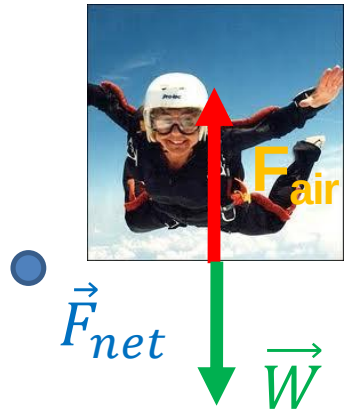

$$|\vec{F}_{net}| = |\vec{W}|$$




$$|\vec{F}_{air}| = \alpha v^2$$

$$\vec{F}_{net} = \vec{W} + \vec{F}_{air}$$

$$|\vec{F}_{net}| < |\vec{W}|$$




$$\vec{F}_{net} = \vec{W} + \vec{F}_{air} = 0$$