Laws of Motion

Let's review... Newton's First Law of Motion states that:

an object in motion stays in motion; an object at rest stays at rest... unless acted upon by a net force!

This law is sometimes thought of as the Law of Inertia, where inertia is the ability to resist change (aka keep doing what's it doing ☺)

Examples of inertia from driving:

Sudden Starts:

- head rests stop the head from being pushed back.
- the coffee tends to spill on you.

Sudden Stops:

- seat belts help your body resist the tendency to keep moving.
- the coffee tends to spill forward.

Turning:

- getting pushed to the outside of the turn

All objects have inertia but objects with larger masses have more!

Mass (kg) is measure of the amount of matter in an object. Do not confuse mass with weight!

- Weight is the force of gravitational attraction. $\vec{F}_g = m\vec{g}$
- Mass is constant throughout the universe but weight changes depending on location.

3. Newton's Second Law of Motion:

- The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object.

- In other words, the net force is equal to mass times the acceleration.

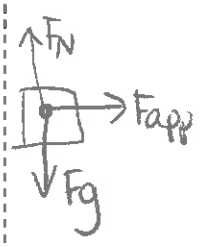
$$\Sigma \vec{F}_{net} = m \cdot a$$

To find F_{net} when two forces work together ...
add them up!

To find F_{net} when many forces act on an object:
F_{net} = Winners − Losers

2. Stan and Kyle are pushing a 75 kg sled along a frictionless icy surface. Stand pushes with 55 N and Kyle pushes with 25 N. Find the sled's acceleration.

$\Sigma \vec{F}_{net} = F_{Stan} + F_{Kyle} = m \cdot a$



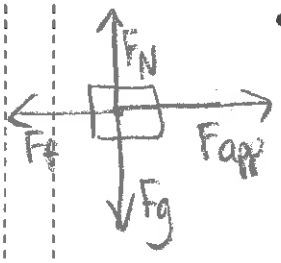
$a = \frac{F_{Stan} + F_{Kyle}}{m}$

$= \frac{55N + 25N}{75kg}$

$= 1.1\ m/s^2$ [Fwd]

3. A 1200kg car accelerates at 5.85 m/s^2. If the force of friction acting on the car is 2800 N, how much force does the engine exert?

$\Sigma \vec{F}_{net} = m \cdot a$



$F_{app} - F_f = m \cdot a$

$F_{app} = F_f + m \cdot a$

$= 2800N + 1200kg \cdot \frac{5.85 m}{s^2}$

$= 9820N$

$= 9800N$ [Fwd]

4. A student pulls straight upwards with a force of 650 N on their 15 kg backpack. What is the backpack's acceleration?

$\Sigma \vec{F}_{net} = m \cdot a$

$F_{app} - F_g = m \cdot a$

$a = \frac{F_{app} - F_g}{m}$

$= \frac{F_{app} - mg}{m}$

$= \frac{650N - 15kg(9.8 m/s^2)}{15kg}$

$= 33.5 \frac{kg \cdot \frac{m}{s^2}}{kg}$

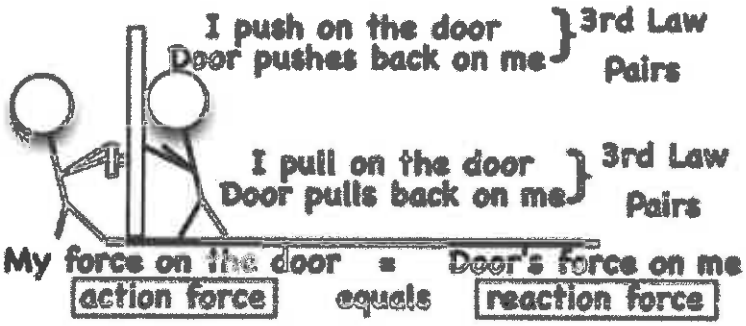
$= 34\ m/s^2$ [up]

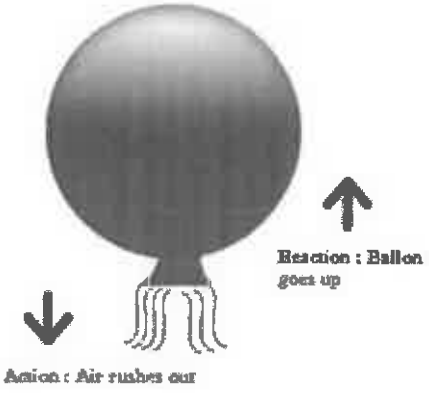
Newton's Third Law of Motion states that:

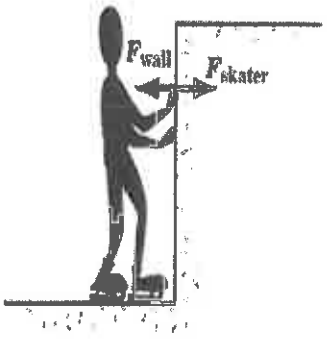
For every action force, there exists a simultaneous reaction force that is equal in magnitude but opposite in direction

This is also called the action - reaction principle.

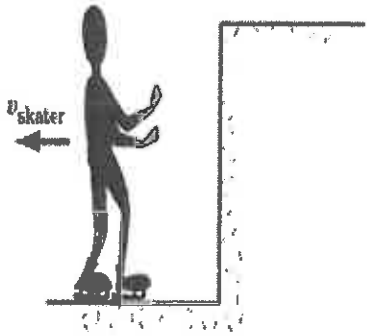
Examples action-reaction:







skater pushes on wall



skater recoils off wall

Imagine a bug hitting the windshield of a semi trailer.

What force pair occurs?

truck hits bug - bug hits truck

Which force is bigger?

NEITHER!

$F_B - F_T$

$m_B a_B = m_T a_T$

$\downarrow \uparrow = \uparrow \downarrow$

Which object has a greater acceleration?

The bug since $m_{bug} << m_{truck}$