

Newton's 3 Laws of Motion:

- 1<sup>st</sup> Law: Law of Inertia. Objects in motion...
- 2<sup>nd</sup> Law:  $F=ma$
- 3<sup>rd</sup> Law: Action/reaction

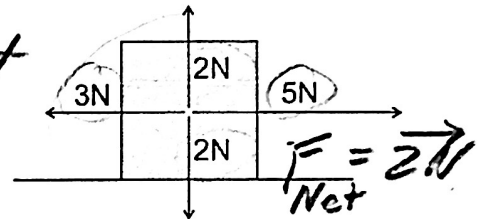
Net force ( $F_{net}$ ):

The vector sum of all of the forces acting on an object

(an arrow, indicating direction)

What is the net force that is acting on the box to the right?

2N rightward



Newton's 1<sup>st</sup> Law:

- The usual version: Objects in motion remain in motion in a straight line and at a constant speed, and objects at rest stay at rest, unless they are acted upon by an outside (or unbalanced) force.

- Another version: If an object is experiencing a net force, it is accelerating.

If it's not, it won't accelerate.

Newton's 1st Law is called the "Law of Inertia." Inertia is: Resistance to change in motion

acceleration

What kinds of objects have the most inertia?

Massive Objects  
(trains, planets, anvils...)

Newton's 2nd Law:  $F_{net} = ma$

mass

acceleration

Mass: A measure of something's inertia.

The unit we will use for mass is the Kilogram, which is abbreviated kg

↑  
Nalgene bottle full of water


Force: a push or a pull

The unit we will use for force is the Newton, which is abbreviated N

Consider a child pushing a toy car. The net force applied to the car equals the mass of the car multiplied by the car's acceleration. Starting with an ordinary  $F = ma$ , show what would happen to the sizes of  $F$ ,  $m$ , and  $a$  if...

$$F = ma$$

- The car's mass is increased, but the applied force is kept the same.

$$F = Ma$$


- The car's mass is decreased, but the applied force is kept the same.

- The car has the same mass, but it accelerates faster.

$$F = ma$$
$$F = ma$$

- The car has the same mass, but less force is applied to the car.

$$F = Ma$$

### Newton's 3<sup>rd</sup> Law:

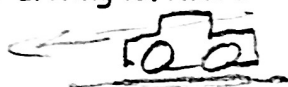
State Newton's 3<sup>rd</sup> Law of Motion:

For every action<sup>(force)</sup>, there is an equal and opposite reaction<sup>(force)</sup>.

Describe some examples of action/reaction pairs demonstrating Newton's 3<sup>rd</sup> Law.

- Walking Rightward: Foot pushes ground leftward; ground pushes foot rightward.

- Car driving leftward: Tire pushes road rightward; road pushes tire left



- Helicopter flying upward: Blades push air down; Air pushes blades up

- Gun shooting bullet rightward: Gun pushes bullet right; bullet pushes gun left.



In the case of a gun and a bullet, what is equal and opposite, and what is not? Explain.

forces

masses  
and  
accelerations