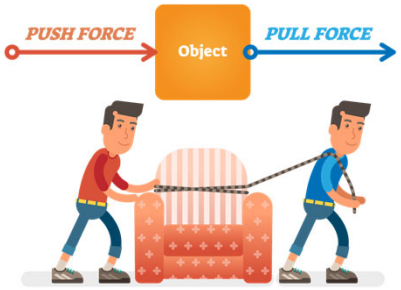
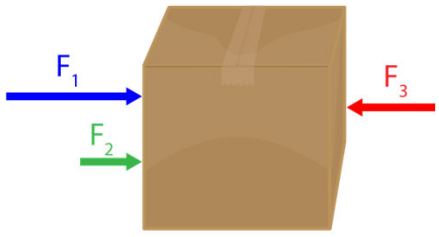
Force

- A force pushes or pulls an object.

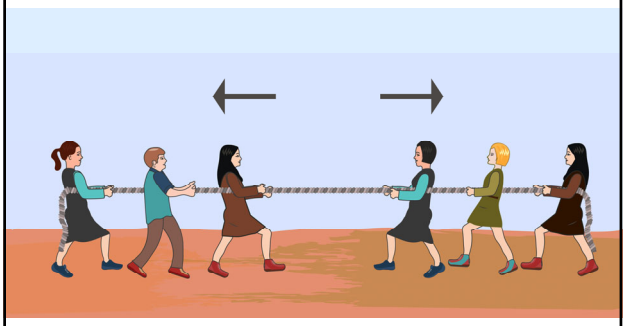


- When multiple forces act on an object, the forces combine.
- The combined (or total) force is called the net force.



$F_{net} = F_1 + F_2 - F_3$

- Forces are considered balanced when the net force equals zero.



Newton's Laws of Motion

- Isaac Newton (English)
  - *Principia* (1588)
- Newton's laws of motion allowed motion on Earth and in space to be predicted mathematically.

AXIOMS, OR LAWS OF MOTION.

LAW I.

Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon.

Projectiles persevere in their motions, so far as they are not retarded by the resistance of the air, or impelled downwards by the force of gravity. A top, whose parts by their cohesion are perpetually drawn aside from rectilinear motions, does not cease its rotation, otherwise than as it is retarded by the air. The greater bodies of the planets and comets, meeting with less resistance in more free spaces, preserve their motions both progressive and circular for a much longer time.

LAW II.

The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.

If any force generates a motion, a double force will generate double the motion, a triple force triple the motion, whether that force be impressed altogether and at once, or gradually and successively. And this motion (being always directed the same way with the generating force), if the body moved before, is added to or subducted from the former motion, according as they directly conspire with or are directly contrary to each other; or obliquely joined, when they are oblique, so as to produce a new motion compounded from the determination of both.

LAW III.

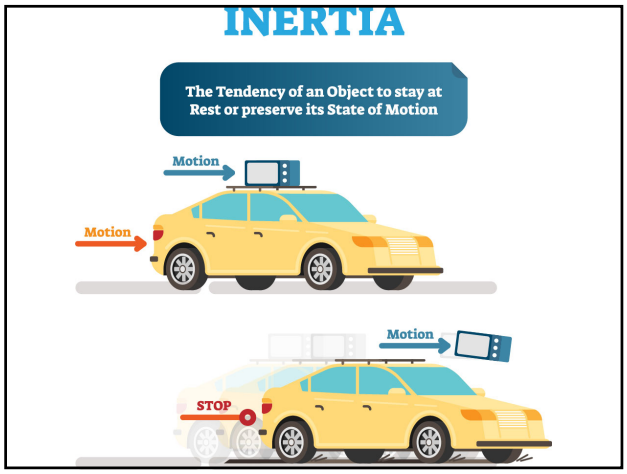
To every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.

Whatever draws or presses another is as much drawn or pressed by that other. If you press a stone with your finger, the finger is also pressed by the stone. If a horse draws a stone tied to a rope, the horse (if I may so say) will be equally drawn back towards the stone: for the distended rope, by the same endeavour to relax or unbend itself, will draw the horse as much towards the stone, as it does the stone towards the horse, and will obstruct the progress of the one as much as it advances that of the other.

Newton's First Law

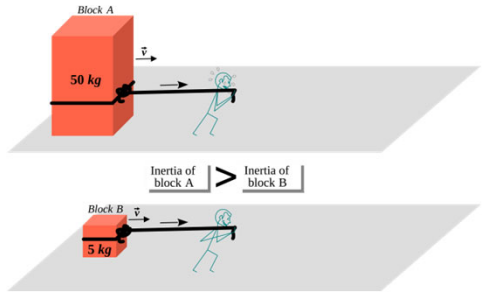
- A body at rest tends to remain at rest. A body in motion tends to move in a straight line with constant speed unless an unbalanced force acts on it.
  - Objects want to keep doing what they are already doing.

- Newton's first law incorporates a concept first described by Galileo (Italian): **inertia**.
  - Newton's first law is often referred to as the Law of Inertia.
- **Inertia** is the tendency for an object at rest to remain at rest, or for a moving object to remain in motion in a straight line with constant speed.



- As we know from experience, some objects have more inertia than others.
  - Changing the motion of a large truck is more difficult than changing the motion of a toy truck.

- The **inertia** of an object is proportional to the mass of the object.
- **Mass** is a measure of the amount of matter (or stuff) in an object.

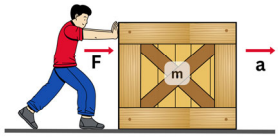


Friction

- Friction is an external force that acts opposite to the direction of relative motion or to prevent slipping.

Newton's Second Law

- The acceleration of a body is proportional to the net force acting on it. The acceleration is in the same direction as the net force.



Force(F) = mass(m) x acceleration(a)

F = ma

Newton's Third Law

- For every action force there is a reaction force.
  - Forces always come in pairs.