Force, Net Force, & Inertia

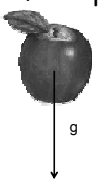
Sir Isaac Newton

What Is a Force?

- A Force is an *interaction between two bodies*.
  - Convention: $\boldsymbol{F}_{a,b}$ means "the force acting on *a* due to *b*".
- A Force is a *push* or a *pull*.
- A Force has magnitude & direction **(vector)**.
- Adding forces means adding vectors.

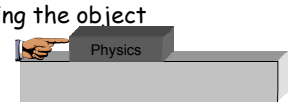
Force Units

- English unit for Force is the pound
- SI unit for Force is the Newton (N)
- 1 N ~ 1/5 lb – the weight of an apple

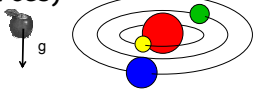


Forces

- Contact (fundamentally E+M)
  - Normal: Perpendicular to surface
  - Friction: Parallel to surface
  - Anything touching the object
    - Rope: Tension
    - Spring F = -kx
    - Person



- Non-Contact or Action at a Distance (these are field forces)
  - Gravity
  - Electromagnetic



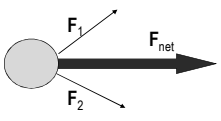
Types of Forces

- Action-at-a-Distance, any force that does not need the objects touching
  - Gravity
  - Electro-Magnetic
  - Weak Nuclear
  - Strong Nuclear

  We will only deal with the first two

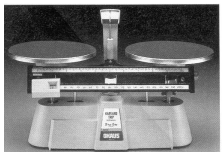
Net Force

- Net force is the vector sum of all forces on an object ($F_{net} = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 + \ldots$)
- Net force causes acceleration



Inertia

- Inertia is the tendency of any body to resist change in its state of motion
- Inertia is measured by measuring mass

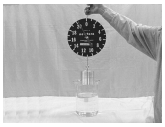


Mass v. Weight

- Mass and Weight <u>are not the same</u>
- Mass is the measure of matter in an object, and the measure of inertia
- Weight is the force of gravity on mass
- A man with a mass of 100 kg weighs 980 N on Earth and 162 N on the moon and 371 N on Mars, but his mass is always 100 kg.

mass

weight



Mass v. Volume

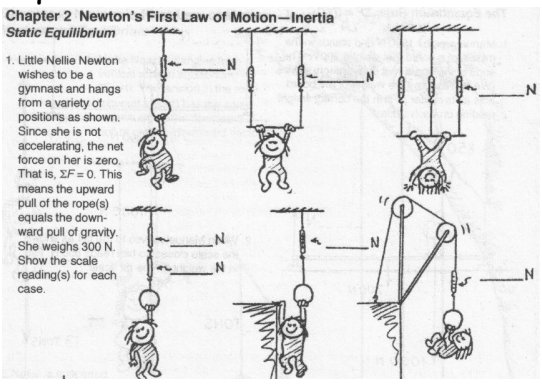
- Volume is the amount of 3-D space an object takes up
- At room temperature, 1 kg of Lead takes up 88 cm^3; 1kg of Water takes up 1000 cm^3. (1 liter = 1000 cm^3)
- Both the Lead and the Water have the same amount of inertia

Newton 1

- Newton's First Law -- Law of Inertia
- A body moving at a constant velocity will stay at that velocity, and a body at rest will stay at rest, until an unbalanced force acts on that body
  - If no net forces act, there is no acceleration.

$$\vec{F}_{net} = 0 \Leftrightarrow \vec{a} = 0$$

Equilibrium $\vec{F}_{net} = 0 \Leftrightarrow \vec{a} = 0$



Chapter 2 Newton's First Law of Motion—Inertia

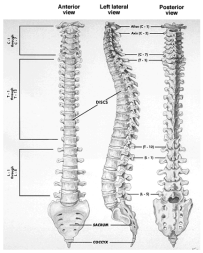
Static Equilibrium

1. Little Nellie Newton wishes to be a gymnast and hangs from a variety of positions as shown. Since she is not accelerating, the net force on her is zero. That is, $\Sigma F = 0$. This means the upward pull of the rope(s) equals the downward pull of gravity. She weighs 300 N. Show the scale reading(s) for each case.

N N N N N N

Hammers and Height

- Hammer Tightening
- Height



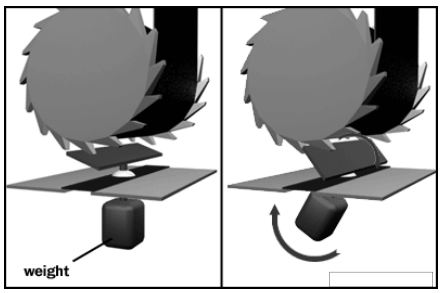
You are as much as 1 cm taller in the morning.

Inertia & Seatbelts

- What function do seatbelts serve?

http://hyperphysics.phy-astr.gsu.edu/hbase/seatb.html

Seatbelt Locking Mechanism



The Marker, The Hoop and The Flask

- What will happen to the Marker if the hoop is quickly removed?

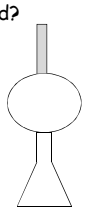


Table Cloth