Center of Mass

Center of Mass/Center of Gravity

- COM (or Center of Gravity) – the average position of a system's mass.
  - "balancing point"

- For a two-particle system:

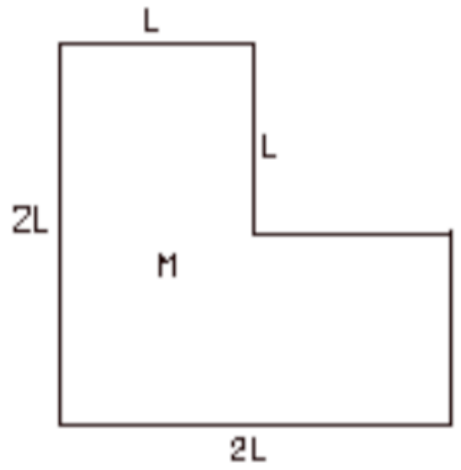
$$x_{com} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{m_1 x_1 + m_2 x_2}{M}$$

- For a multi-particle system:

$$x_{com} = \frac{1}{M} \sum_{i=1}^{n} m_i x_i$$

Ex1: Two particles of 2 kg and 4 kg are located at (1, 4) and (3, -2) in the x-y plane. Find the COM.

Ex2: Find the COM of the shape. Let M=3.
(Hint: Divide shape into 3 smaller squares. Use center of each.)



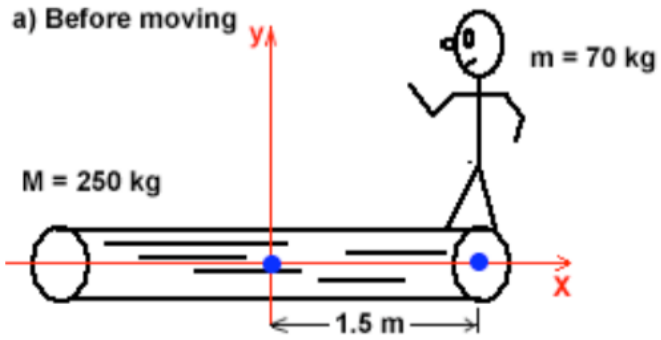
Why do we care about the COM?

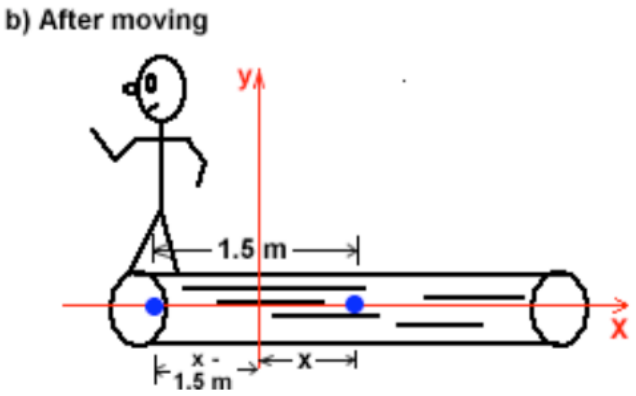
- The COM is the point that moves as though all of the system's mass were concentrated at that point, and all of the external forces were applied there.
- The COM of an object of uniform density is the body's geometric center.
- The COM does not need to be located within the object itself.
  - The COM of a donut is in the center of its hole!

$$F_{net} = ma_{cm}$$

- If there are no external forces, the COM can't move.

Ex3: A 70 kg man is standing on the end of a 250 kg log that is floating on the water. Both the man and the log are at rest, and the log is 3 m long. Where is the COM located?





If the man walks to the other end of the log, how far will the log move in the water? Ignore any forces exerted on the log by the water.

Ex4: A Chrysler with a mass of 1600 kg is moving along a straight stretch of road at 60 km/h. It is followed by a Ford with a mass of 2400 kg moving at 80 km/h. How fast is the center of mass of the two cars moving?

$$v_{com} = \frac{1}{M}\sum mv$$

** This is the speed the cars would have if they collided and stuck together.