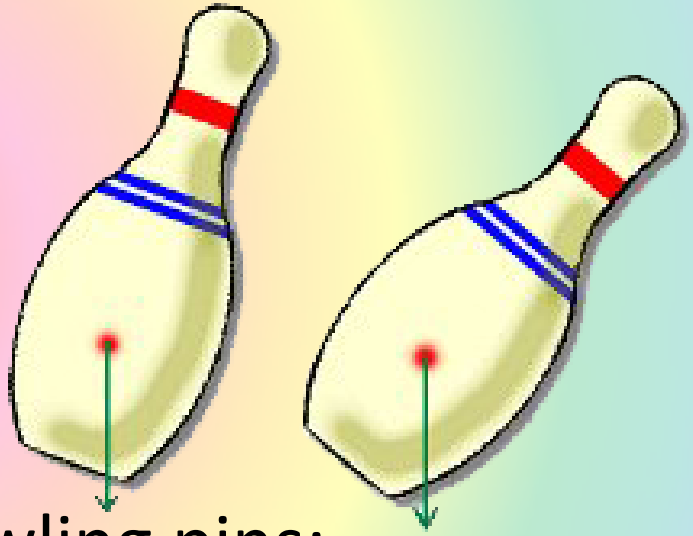
Center of Mass

Balanced, … but How?

- The photographs to the right show objects that are balanced but look like they should fall over.
- What keeps them from falling over when they look so unstable?

Distribution of Mass

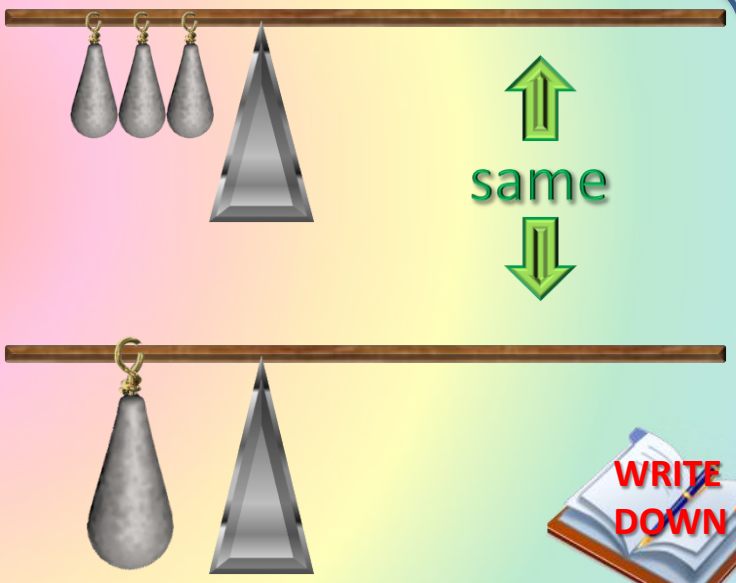
- Objects don't have mass distributed evenly.
- Consider bowling pins:
  - They are fat at the bottom.
  - Most of their mass is down low.
  - This makes them hard to knock over.



- Look at the two pictures of bowling pins:
  - The one on the left will fall back into standing position.
  - Only the one on the right will fall down.
- This is because of the way the mass is distributed.

History

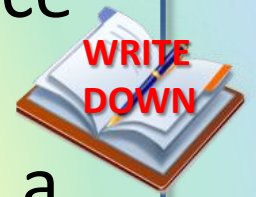
- The ancient Greek mathematician, physicist, and engineer Archimedes studied the way mass was distributed in objects.
- Archimedes showed that a force exerted on a rigid bar by weights resting at various points along the bar is the same as what it would be if all of the weights were moved to a single point.



- This point is called the **center of gravity** or **center of mass**.

An Operational Definition

If you try to balance an object it will only balance over the **center of mass**.



- The center of mass of a system of particles is a specific point at which, for many purposes, the system's mass behaves as if it were concentrated.
- In the case of a rigid body, the position of its center of mass is fixed in relation to the object (but not necessarily in contact with it).
- The center of mass of a body does not always coincide with its intuitive geometric center.

Significance

- Engineers try to design a sport car center of gravity as low as possible to make the car handle better.
- For a plane to be safe to fly, the center of gravity should be about one quarter of the way from the wing leading edge to the wing trailing edge.
- The relationship between force, mass, and acceleration is easiest to interpret when looking at the behavior of the center of mass.
  - The center of mass is a unique point in an object or system that can be used to describe the system's response to external forces.
  - Consider the bowling pins again:
    - The bowling pin's weight pulls the left pin to a standing position
    - The bowling pin's weight pulls the right pin down.