Rotation and Inertia

In Section 4 of the chapter "Circular Motion and Gravitation," you learned that torque measures the ability of a force to rotate an object around some axis, such as a cat-flap door rotating on a hinge. Locating the axis of rotation for a cat-flap door is simple: it rotates on its hinges because the house applies a force that keeps the hinges in place. Now imagine you are playing fetch with your dog, and you throw a stick up into the air for the dog to retrieve. How can you determine the point around which the stick will rotate as it travels through the air?

Center of mass

Unlike the cat-flap door, the stick is not attached to anything. There is a special point around which the stick rotates if gravity is the only force acting on the stick. This point is called the stick's **center of mass.**

The center of mass is also the point at which all the mass of the body can be considered to be concentrated (for translational motion). This means that the complete motion of the stick is a combination of both translational and rotational motion. The stick rotates in the air around its center of mass. The center of mass, in turn, moves as if the stick were a point mass, with all of its mass concentrated at that point for purposes of analyzing its translational motion. For example, the hammer in **Figure 1** rotates about its center of mass as it moves through the air. As the rest of the hammer spins, the center of mass moves along the parabolic path of a projectile.

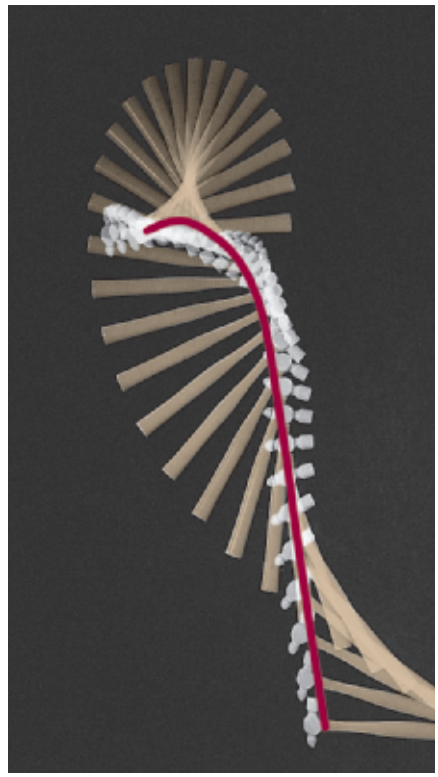

Figure 1
The point around which this hammer rotates is the hammer's center of mass. The center of mass traces out the parabola that is characteristic of projectile motion.

For regularly shaped objects, such as a sphere or a cube, the center of mass is at the geometric center of the object. For more complicated objects, finding the center of mass is more difficult. Although the center of mass is the position at which an extended object's mass can be treated as a point mass, the *center of gravity* is the position at which the gravitational force acts on the extended object as if it were a point mass. For many situations, the center of mass and the center of gravity are equivalent.