31.1: The Coefficient of Restitution

We can compute a dimensionless number called the coefficient of restitution that measures how elastic a collision is. The coefficient of restitution ϵ is defined as

$$\epsilon = \frac{p_f}{p_i}, \tag{31.1.1}$$

where p_f is the final momentum of the body, and p_i is its initial momentum. For a perfectly elastic collision, $\epsilon = 1$; for a perfectly inelastic collision, $\epsilon = 0$; and for an inelastic collision, ϵ is some number between 0 and 1 , being closer to 1 the more elastic it is.

An easy way to measure the coefficient of restitution is to drop a body on a flat surface. The height to which the body rebounds will determine the coefficient of restitution. Suppose the body is initially dropped from a height h_i, and rebounds to a height h_f. By conservation of energy, the kinetic energy of the body just before it hits the floor is $mv_i^2/2 = mgh_i$, so its velocity is $v_i = \sqrt{2gh_i}$. Similarly, just after the collision the velocity is $v_f = \sqrt{2gh_f}$. Therefore the coefficient of restitution ϵ is

$$\epsilon = \frac{p_f}{p_i} = \frac{mv_f}{mv_i} = \frac{v_f}{v_i} = \frac{\sqrt{2gh_f}}{\sqrt{2gh_i}} \tag{31.1.2}$$

or

$$\epsilon = \sqrt{\frac{h_f}{h_i}} \tag{31.1.3}$$

The coefficient of restitution is just the square root of the ratio of the rebound height to the initial height. [1]

Now let's first look at a mathematical analysis of collisions in one dimension, where the anaysis is simpler. At the end of the chapter we'll examine collisions in two dimensions.

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