2.1: Definition of Moment of Inertia

Consider a straight line (the "axis") and a set of point masses m_1, m_2, m_3 ... such that the distance of the mass m_i from the axis is r_i. The quantity $m_i r_i^2$ is the second moment of the i th mass with respect to (or "about") the axis, and the sum $\sum m_i r_i^2$ is the second moment of mass of all the masses with respect to the axis.

Apart from some subtleties encountered in general relativity, the word "inertia" is synonymous with mass - the inertia of a body is merely the ratio of an applied force to the resulting acceleration. Thus $\sum m_i r_i^2$ can also be called the **second moment of inertia**. The second moment of inertia is discussed so much in mechanics that it is usually referred to as just "the" moment of inertia.

In this chapter we shall consider how to calculate the (second) moment of inertia for different sizes and shapes of body, as well as certain associated theorems. But the question should be asked: "What is the purpose of calculating the squares of the distances of lots of particles from an axis, multiplying these squares by the mass of each, and adding them all together? Is this merely a pointless make-work exercise in arithmetic? Might one just as well, for all the good it does, calculate the sum $\sum m_i r_i^2$? Does $\sum r_i m_i^2$ have any physical significance?"