

6.4 Applications of Integration - Work

In Physics, a **force** is a push or pull on an object.

Newton's 2nd Law of Motion: If an object moves along a straight line and its position is given by a function $s(t)$, then the force F on the object is given by

$$F = ma$$

“Force equals mass times acceleration.”

When a force *moves* an object, we say the force does **work** on the object. Work can be thought of as the amount of energy it takes to move an object.

The work W done by exerting a constant force F over a distance d is given by

$$W = Fd.$$

“Work equals force times distance.”

Relevant Units

In the SI metric system:

- Force is measured in Newtons ($N = \text{kg} \cdot \text{m}/\text{s}^2$)
- Mass is measured in kilograms (kg)
- Distance is measured in meters (m)
- Work is measured in Newton-meters (N-m) a.k.a. joules (J)*

In the US Customary system:

- Force is measured in pounds (lbs)
- Distance is measured in feet (ft)
- Work is measured in foot-pounds (ft-lb)

Note:

- The **weight** of an object is the force on the object due to gravity, NOT its mass.
- In the US system, the fundamental unit is the unit of force. (There is a unit of mass, called a slug, but it is not commonly used.)
- Acceleration due to gravity, denoted g , is approximately $9.8 \text{ m}/\text{s}^2$ in SI units and approximately $32 \text{ ft}/\text{s}^2$ in US units.
- The density of water, denoted ρ , is approximately $1000 \text{ kg}/\text{m}^3$ in SI units.

*One joule is the amount of work done by a force of 1 N over a distance of 1 meter.