Section 1.3. Fundamental Concepts

Note. The rate of change of position with respect to time is velocity, and the rate of change of velocity with respect to time is acceleration.

Note. We state Newton's Laws of Motion (from 1687) as:

1. When the sum of the forces acting on a particle is zero, its velocity is constant.
2. When the sum of the forces acting on a particle is not zero, the sum of the forces is equal to the rate of change of the linear momentum of the particle (i.e., force equals mass times acceleration).
3. The forces exerted by two particles on each other are equal in magnitude and opposite in direction.

Note. We can use Newton's second law to define "mass" and "force."

Note. In standard international (SI) units, mass is measured in kilograms (kg), force in newtons (N), distance in meters (m), and time in seconds (s). In U.S. customary units is measured in slugs, force in pounds (lb), distances in feet (ft), and time in seconds (s).

Note. Newton's Law of Universal Gravitation states that two masses of mass m_1 an dm_2 a distance r apart exert a force on each other of magnitude $F = Gm_1m_2/r^2$ where G is the universal gravitational constant.

Note. At the surface of the Earth, we define the force exerted by an object as its *weight* (w). We therefore have

$$w = \frac{Gmm_E}{r^2} = ma \tag{1.2}$$

where m_E is the mass of the Earth and r is the radius of the Earth. Notice that we have

$$a = \frac{Gm_E}{r^2.} \tag{1.3}$$

With g denoting the acceleration at the surface of the Earth, we have $g = 9.81$ m/s^2 or $g = 32.2$ ft/s^2.

Note. See page 7 for a brief discussion of significant digits. *In this book*, you may assume the values given in problems are exact values! Carry through your calculations with as many digits as possible and repeat your answers with as many digits as you deem appropriate (taking your lead from the problem).

Revised: 9/24/2018