## 29.2: Newton’s Second Law of Motion

As shown in Appendix R, Newton's second law of motion, as he originally presented it, is (in modern notation),

$$F = \frac{dp}{dt} \tag{29.2.1}$$

Using the definition of momentum (Eq. 26.1), we get

$$F = \frac{dp}{dt} = \frac{d(mv)}{dt} \tag{29.2.2}$$

$$= m\frac{dv}{dt} + v\frac{dm}{dt}. \tag{29.2.3}$$

If the mass $m$ is constant, then $dm/dt = 0$, and this reduces to

$$F = \frac{dp}{dt} = m\frac{dv}{dt} = ma \tag{29.2.4}$$

So the formulation of Newton's second law $F = ma$ is a special case, that applies when the mass is constant. The more general formulation is $F = dp/dt$.