10.1: Momentum and Newton's Second Law

Up to this point we have stated Newton's second law in its conventional form, $\mathbf{F} = \mathrm{ma}$. However, in the non-relativistic case $\mathrm{ma} = \mathrm{m}d\mathbf{u}/\mathrm{dt} = \mathrm{d(mu)}/\mathrm{dt}$, so we can also write Newton's second law as

$$\mathbf{F} = \frac{d\mathbf{p}}{dt} \quad \text{(Newton's second law)} \tag{10.1.1}$$

where $\mathbf{p} = m\mathbf{u}$ is the non-relativistic kinetic momentum. This form of Newton's second law is actually closer to Newton's original statement of the law. It also has the advantage that it is correct even in the relativistic case when the relativistic definition of kinetic momentum, $\mathbf{p} = m\mathbf{w}\left(1 - u^2/c^2\right)^{1/2}$ (as defined earlier), is substituted.