

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),

$$F = \frac{dp}{dt} \quad (29.2.1)$$

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

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

$$= m \frac{dv}{dt} + v \frac{dm}{dt}. \quad (29.2.3)$$

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

$$F = \frac{dp}{dt} = m \frac{dv}{dt} = ma \quad (29.2.4)$$

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 $F = dp/dt$.

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