10.7 Constancy of Momentum and Isolated Systems

Suppose we now completely isolate our system from the surroundings. When the external force acting on the system is zero,

$$\vec{\mathbf{F}}^{\text{ext}} = \vec{\mathbf{0}}\,. \tag{10.7.1}$$

the system is called an ***isolated system***. For an isolated system, the change in the momentum of the system is zero,

$$\Delta\vec{\mathbf{p}}_{\text{sys}} = \vec{\mathbf{0}} \quad \text{(isolated system)}\,, \tag{10.7.2}$$

therefore the momentum of the isolated system is constant. The initial momentum of our system is the sum of the initial momentum of the individual particles,

$$\vec{\mathbf{p}}_{\text{sys},i} = m_1\vec{\mathbf{v}}_{1,i} + m_2\vec{\mathbf{v}}_{2,i} + \cdots\,. \tag{10.7.3}$$

The final momentum is the sum of the final momentum of the individual particles,

$$\vec{\mathbf{p}}_{\text{sys},f} = m_1\vec{\mathbf{v}}_{1,f} + m_2\vec{\mathbf{v}}_{2,f} + \cdots\,. \tag{10.7.4}$$

Note that the right-hand-sides of Equations. (10.7.3) and (10.7.4) are vector sums.

When the external force on a system is zero, then the initial momentum of the system equals the final momentum of the system,

$$\vec{\mathbf{p}}_{\text{sys},i} = \vec{\mathbf{p}}_{\text{sys},f} \,. \tag{10.7.5}$$

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