Principle of Linear Impulse and Momentum

$$\Sigma \vec{F} = m\vec{a} \qquad \vec{a} = \frac{d\vec{v}}{dt}$$

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$$\int_{t_1}^{t_2} \Sigma \vec{F}\, dt = \int_{\vec{v}_1}^{\vec{v}_2} m\, d\vec{v}$$

$$\Sigma \int_{t_1}^{t_2} \vec{F}\, dt = m\vec{v}_2 - m\vec{v}_1$$

$$m\vec{v}_1 + \Sigma \int_{t_1}^{t_2} \vec{F}\, dt = m\vec{v}_2$$

Principle of Linear Impulse and Momentum

Linear Impulse ($\vec{I}$) Units => N·s

Linear Momentum ($\vec{L}$) Units => kg·m/s

Scalar Equations

$$m(v_x)_1 + \Sigma \int_{t_1}^{t_2} F_x\, dt = m(v_x)_2$$

$$m(v_y)_1 + \Sigma \int_{t_1}^{t_2} F_y\, dt = m(v_y)_2$$

$$m(v_z)_1 + \Sigma \int_{t_1}^{t_2} F_z\, dt = m(v_z)_2$$

- For a System of Particles
  - Linear impulse due to internal forces always cancel out (the forces are equal and opposite, and time is the same for all particles)

$$\Sigma m_i(\vec{v}_i)_1 + \Sigma \int_{t_1}^{t_2} \vec{F}_i\, dt = \Sigma m_i(\vec{v}_i)_2$$

  - Can also use the center of mass for the system

$$m(\vec{v}_G)_1 + \Sigma \int_{t_1}^{t_2} \vec{F}_i\, dt = m(\vec{v}_G)_2$$

(m: total mass)

Conservation of Momentum

- If the particle(s) is free of external forces

$$mv_1 = mv_2$$

$$\Sigma m_i(v_i)_1 = \Sigma m_i(v_i)_2$$