Momentum
\[ \mathbf{p} = m \mathbf{v} \]
units: kg \(\cdot\) m/s = N\(\cdot\)s

Inertia is resistance to changes in velocity. \(\mathbf{v}\) depends on reference frame, \(\Delta \mathbf{v}\) does not, for inertial frames.

Newton's 2nd Law
\[ \mathbf{F} = \frac{d\mathbf{p}}{dt} = m \mathbf{a} \] for \(m\) constant.

Impulse is change in momentum
\[ \mathbf{I} = \Delta \mathbf{p} = \int_{t_0}^{t_f} \mathbf{F} \, dt = \langle \mathbf{F} \rangle \Delta t \]
Same units as momentum

What is the impulse on a ball that has mass \(m\), is dropped on the floor from height \(h\) and returns to the same height?
\[ \mathbf{I} = 2m \sqrt{2gh} \]

Conservation of Momentum
If no unbalanced net force acts on a system of masses, then the total momentum of the system is constant.
\[ \sum \mathbf{p}_i = \sum \mathbf{p}_f = 0 \]

\[ \mathbf{v}_1 \mathbf{f} = - \frac{m_2}{m_1} \mathbf{v}_2 \mathbf{f} \]

The forces between masses are internal to the system

For every impulse on \(A\) from \(B\), there is an equal/ Opposite impulse on \(B\) from \(A\)
\[ \Delta \mathbf{p}_A = \langle \mathbf{F}_{AB} \rangle \Delta t = - \langle \mathbf{F}_{BA} \rangle \Delta t = - \Delta \mathbf{p}_B \]

A bomb explodes into 3 fragments

\[ \Delta \mathbf{p} = 2N\mathbf{S} \]