Momentum

- Object specific measure of an objects state of motion.

State of motion $\Rightarrow V$

Object specific $\Rightarrow m$

Equation

$$p = mV$$

m = mass (kg)

V = velocity (m/s)

p = momentum (Ns) or (kg m/s)

Impulse

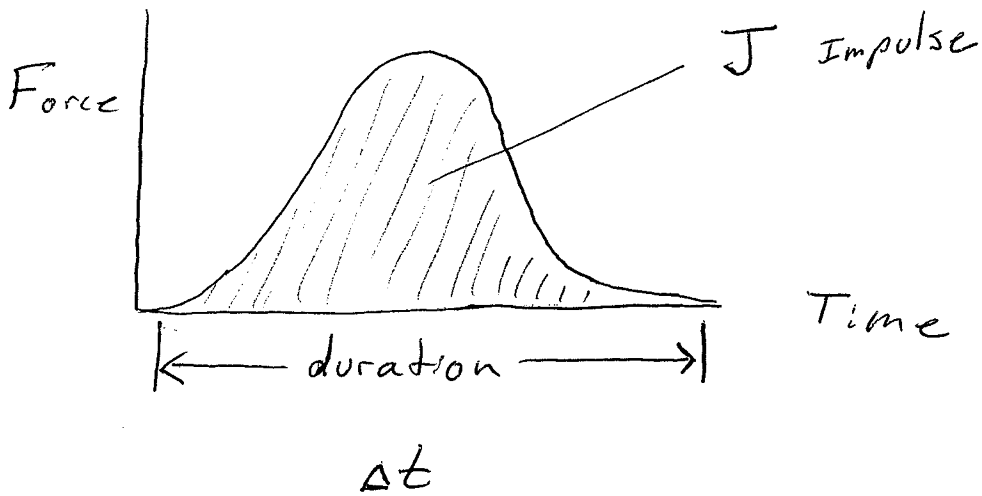
- Force acting for some time interval that causes a change in momentum.

Equation

$$J = F\Delta t = \Delta p$$ * For a constant or average force

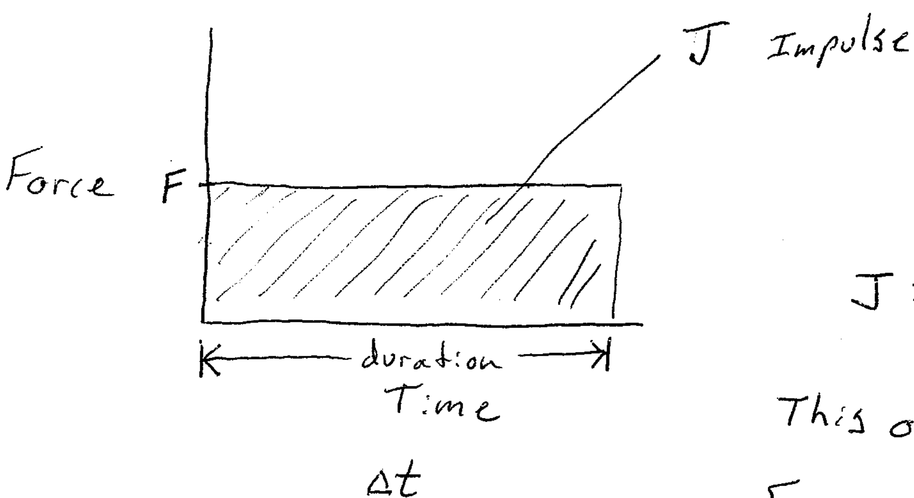
F = force (N)

Δt = time of contact (s)



Notice that integration is needed to determine the impulse.

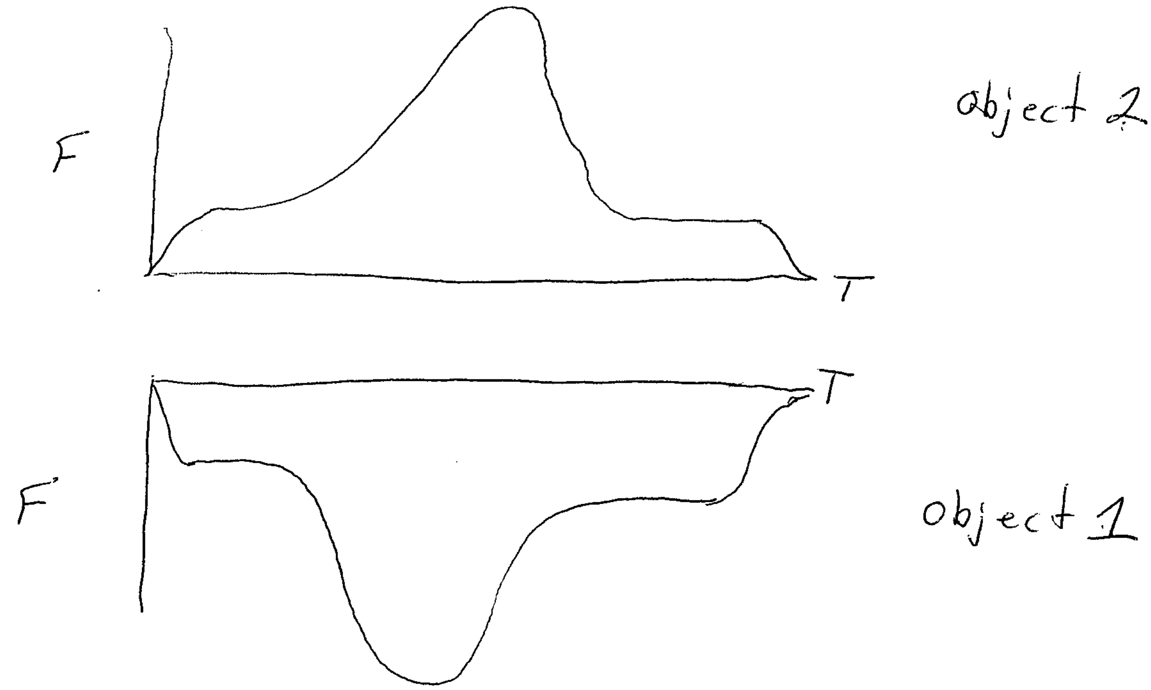
$$J = \int F(t)\, dt$$

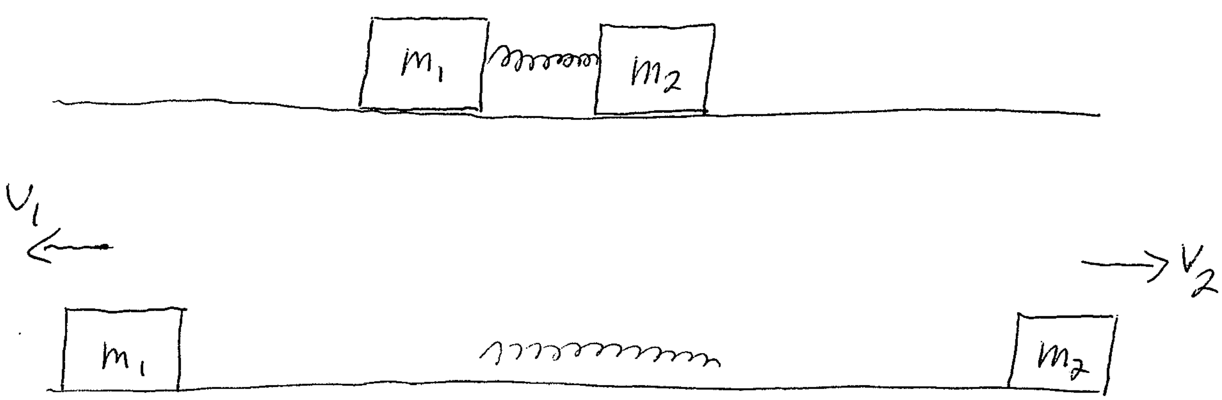


$$J = F\Delta t$$

This only applies when F is constant

An impulse, like force, acts <u>between</u> two objects.





* Both objects experience the same magnitude of force and impulse.

* The force and impulse act in opposite directions by Newton's Third Law.

Newton's Second Law -- (Momentum Version)

$$\vec{F} = m\vec{a} = m\frac{d\vec{v}}{dt} = \frac{d(m\vec{v})}{dt} = \frac{d\vec{p}}{dt}$$

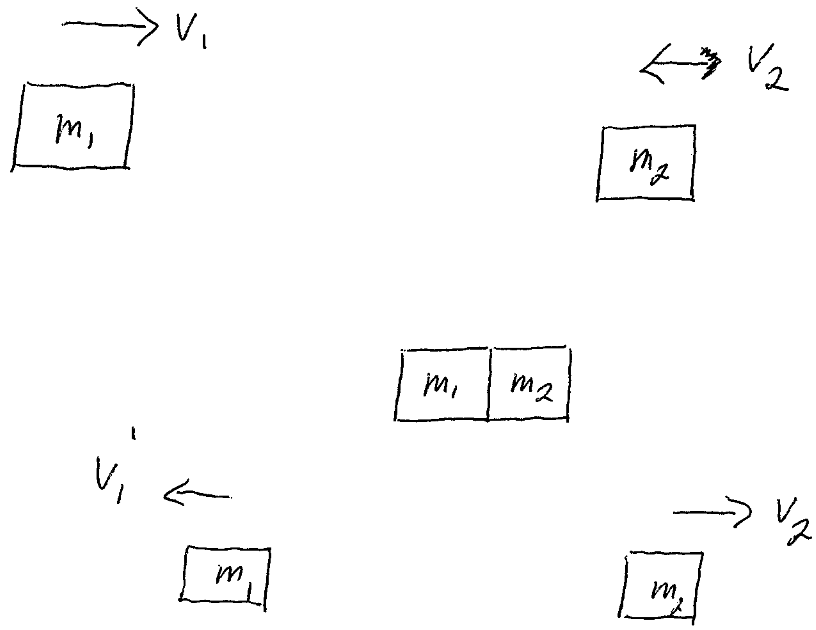
$$\vec{F}(t) = \frac{d\vec{p}}{dt}$$

Integrate both sides

$$\int F(t)\,dt = \vec{p}(t) + C^{*} = J$$

* where C can be found from your initial conditions.

Newton's Third Law



$$F_{m_1 \text{ on } m_2} = -F_{m_2 \text{ on } m_1}$$

$$F_{m_1 \text{ on } m_2} \Delta t = -F_{m_2 \text{ on } m_1} \Delta t$$

$$J_{\text{on } m_2} = -J_{\text{on } m_1}$$

$$\Delta p_{m_2} = -\Delta p_{m_1}$$

$$m_2 v_2' - m_2 v_{2_0} = -(m_1 v_1' - m_1 v_{1_0})$$

$$m_2 v_2' - m_2 v_{2_0} = -m_1 v_1' + m_1 v_{1_0}$$

$$m_2 v_2' + m_1 v_1' = m_2 v_{2_0} + m_1 v_{1_0}$$

$$\Sigma p = \Sigma p_0$$

$\Longrightarrow$ Momentum is a conserved Quantity