Momentum and Impulse

$$\vec{F} = ma = m\frac{\Delta\vec{v}}{\Delta t},$$

$$\boxed{\Delta\vec{p} = \vec{F}\Delta t}$$

$\vec{p} = m\vec{v}$ called Momentum

$\vec{F}\Delta t$ called Impulse

Conservation of Momentum

2nd Newton's Law for ***n*** objects:

$$\Delta\vec{p}_1 = \vec{F}_1\Delta t$$

$$\Delta\vec{p}_2 = \vec{F}_2\Delta t$$

.....

$$\Delta\vec{p}_n = \vec{F}_n\Delta t$$

3rd Newton's Law, no external forces!

$$\vec{F}_1 + \vec{F}_2 + ... + \vec{F}_n = 0$$

$$\Delta\left(\vec{p}_1 + \vec{p}_2 + ... + \vec{p}_n\right) = 0$$

$$\vec{p}_1 + \vec{p}_2 + ... + \vec{p}_n = const$$

Total Momentum of Isolated System is Conserved

Homework

Problem 1

A block of mass ***M=100g*** moves with speed of ***v=10m/s*** on a frictionless flat surface. A bullet of mass m=8g that moves with speed ***u=700 m/s*** in the opposite direction, hits the block and gets stuck in it. What will be the velocity of the block after this collision (include direction in your response)?

Problem 2

An empty bottle rocket has mass ***M=100 g***. It is filled with ***m=800g*** of water. During the lunch, the water quickly jets out of the nozzle with average speed ***v=5m/s*** (in the reference frame of the ground). Find the speed of the rocket after it empties.