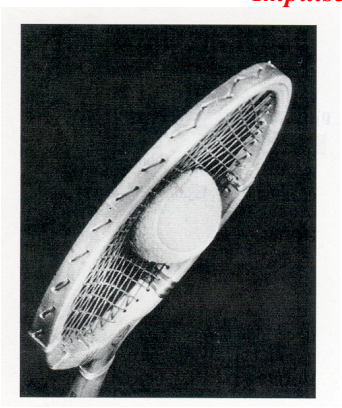
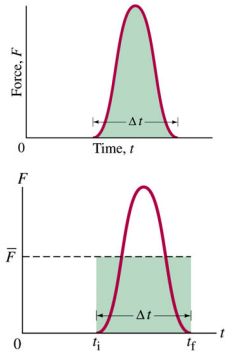
Physics 2A

Momentum

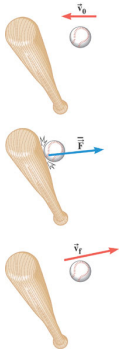
Impulse
Impulse-Momentum Theorem

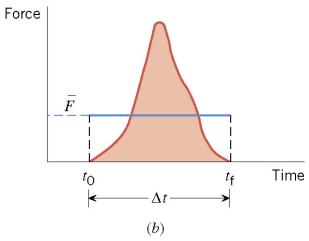
Impulse





Impulse





There are many situations when the force on an object is not constant.

Impulse

DEFINITION OF IMPULSE

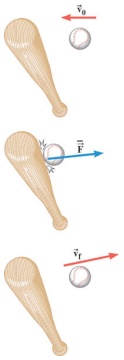
The impulse of a force is the product of the average force and the time interval during which the force acts:

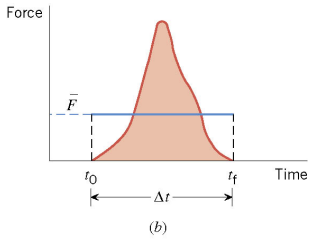
$$\vec{\mathbf{J}} = \vec{F}_{avg}\Delta t$$

Impulse is a vector quantity and has the same direction as the average force.

$$\text{newton} \cdot \text{seconds}\ (\text{N} \cdot \text{s})$$

Impulse





$$\vec{\mathbf{J}} = \vec{F}_{avg}\Delta t$$

Impulse-Momentum Theorem

When a net force acts on an object, the impulse of this force is equal to the change in the momentum of the object

impulse

$$\vec{F}_{avg}\,\Delta t = m\vec{\mathbf{v}}_{\mathbf{f}} - m\vec{\mathbf{v}}_i$$

final momentum

initial momentum

Impulse-Momentum Theorem

$$\vec{F}_{avg}\Delta t = m\Delta\vec{v}$$

$$\vec{F}_{avg}\Delta t = \Delta\vec{p} = m(\vec{v}_f - \vec{v}_i)$$

$$\vec{J} = \Delta\vec{p} = m(\vec{v}_f - \vec{v}_i)$$

Impulse-Momentum Theorem

$$\vec{F}_{avg}\Delta t = \Delta\vec{p} \;\rightarrow\; \vec{F}_{avg} = \frac{\Delta\vec{p}}{\Delta t}$$

⇒ In a collision where an object is brought to rest, the change in momentum is the same whether the collision takes place over a long time or over a short time.

⇒ However, the greater the time, the lower the average net force.

Impulse-Momentum Theorem

Decreasing momentum over a long time ⇒ The greater the time a force acts to decrease the momentum, the smaller the average net force

examples : catching an egg toss,
padded dashboards, airbags, crumple zones,
bungee jumping, dynamic ropes for rock climbing,
padded exercise mats,
bending knees when jumping down

Impulse-Momentum Theorem

Increasing momentum ⇒ To get the maximum change in momentum, you want to apply the greatest force and extend the time of application.

examples : long barrel of a cannon or shotgun,
long push on stalled car,
follow through when hitting a ball