Physics

Lecture 12
Impulse & Momentum

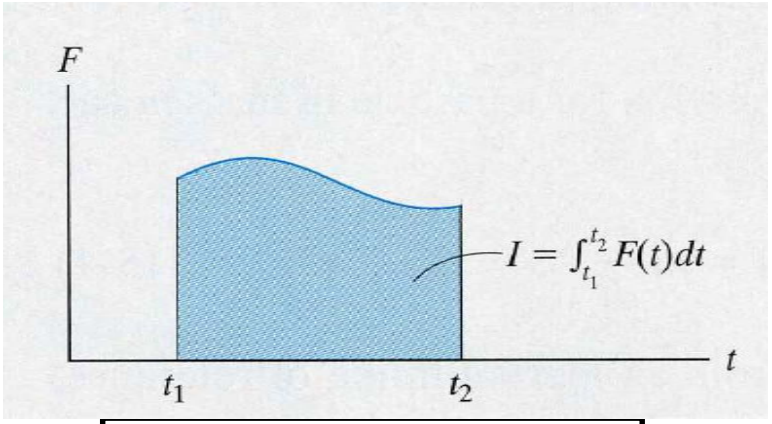
Today's Contents

- **Impulse of a force**
- **Momentum of a particle**
- **Principle of linear impulse and momentum**

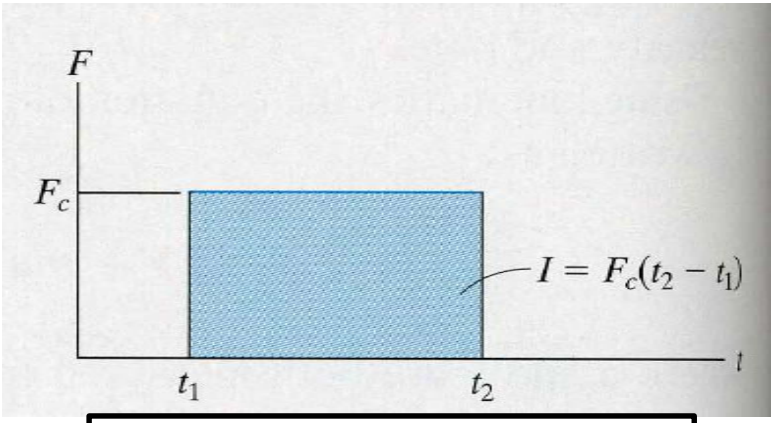
Linear Impulse

Impulse of a force **F** in the time interval t_1 to t_2 **(I)**

Linear impulse **Unit is N·s**



Variable force



Constant force

Linear Momentum

Momentum of a particle $\boldsymbol{G} = m\boldsymbol{v}$

- **Momentum is a vector quantity that acts in the same direction as the velocity**

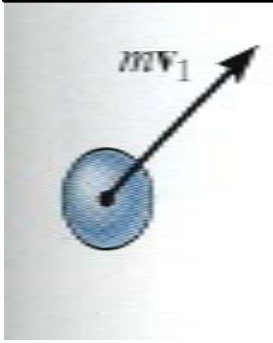
Force - momentum relationship

$$\dot{\boldsymbol{G}} = \boldsymbol{F}$$

Resultant force = Rate of change of the momentum

Principle of Linear Impulse and Momentum

Initial momentum diagram



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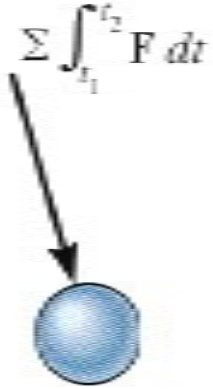

Impulse diagram

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Final momentum diagram

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

This is called the Impulse - Momentum method

Work Energy Method Vs. Impulse Momentum Method

- **Work is a scalar quantity that is associated with a force and a change in the position of the point of application**
- **Impulse is a vector quantity associated with a force and a time interval.**
- **Kinetic energy is a scalar quantity associated with a mass and its speed at an instant of time**
- **Momentum is a vector quantity associated with a mass and its velocity vector at an instant of time**
- **The work-energy principle is a scalar relationship, whereas the impulse-momentum principle is a vector relationship**

Principles of Conservation of Linear Momentum

$$\Delta \boldsymbol{G} = 0$$

If the Impulse acting on a particle is zero during a given time interval, the momentum of the particle will be conserved during that interval

- **If there is no resultant force, the momentum will be conserved.**
- **Impulse can be zero, even if the force is not zero.**
- **It is possible that one or two components of impulse will be conserved even though the total momentum itself is not conserved.**