Tishk International University
Faculty of Applied Science

Medical Technical Radiology
General Physics

MOMENTUM

First Grade- 2025-2026

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Learning outcomes

At the end of the session, you should be able to:-

- **Momentum**
- **Linear Momentum & Its Equation**
- **Impulse-Momentum Theorem**
- **Conservation of Momentum**
- **Elastic & Inelastic Collisions**
- **Real-Life Applications**

What is Mass?

Mass, in physics, is defined as the measure of the amount of matter present in an object or a system. Mass is a characteristic of an object and is independent of its location or the forces acting upon it. The standard unit of mass in the International System of Units (SI) is the kilogram (kg).

What is Mass?

- **Mass** is the **amount of matter** contained in an object.
- It is a **fundamental property** of matter.
- Mass **does not change** with location (Earth, Moon, space).
- It is **independent of gravity** and external forces.
- **SI unit:** kilogram (**kg**)

- **Mass and Weight**

- It is important to note that mass is distinct from weight. Weight is the force experienced by an object due to the gravitational pull of the Earth. Mass remains constant regardless of the gravitational field, whereas weight varies depending on the strength of gravity. Mass is a scalar quantity, meaning it only has magnitude and no direction.

- **What is the difference between mass and weight?**

- Mass is the measure of the quantity of matter in an object, while weight is the force exerted on an object due to gravity. Mass remains constant, while weight varies depending on the strength of gravity.

Difference Between Mass and Weight

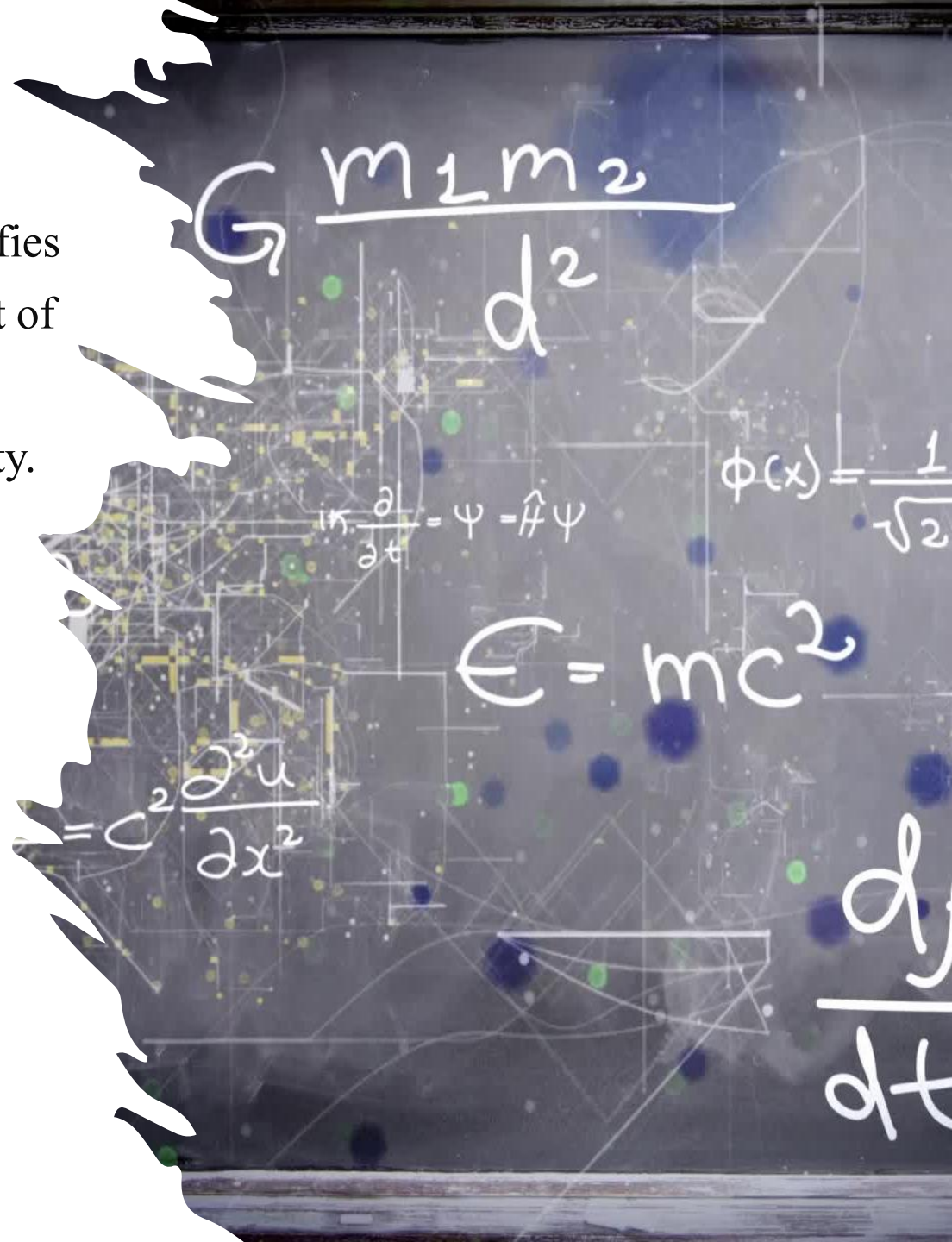
Mass	Weight
• Amount of matter	• Force due to gravity
• Constant everywhere	• Changes with gravity
• Scalar quantity	• Vector quantity
• Unit: kilogram (kg)	• Unit: Newton (N)
• Measured by balance	• Measured by spring scale
 Unit: kilogram (kg)	• Unit: Newton (N)
Measured by balance	• Measured by spring scale

- **What is Momentum?**

❑ Momentum is a fundamental concept in physics that quantifies the motion possessed by an object. It is defined as the product of an object's mass and velocity. In other words, momentum is determined by multiplying the mass of an object by its velocity.

❑ The formula to calculate momentum is:

- **Momentum = Mass × Velocity**
- Symbolically, it can be expressed as:
- **p = mv**
- *Where p is the momentum, m is the mass and v is the velocity*



Linear Momentum, *continued*

- **Impulse**
  - The product of the force and the time over which the force acts on an object is called **impulse.**

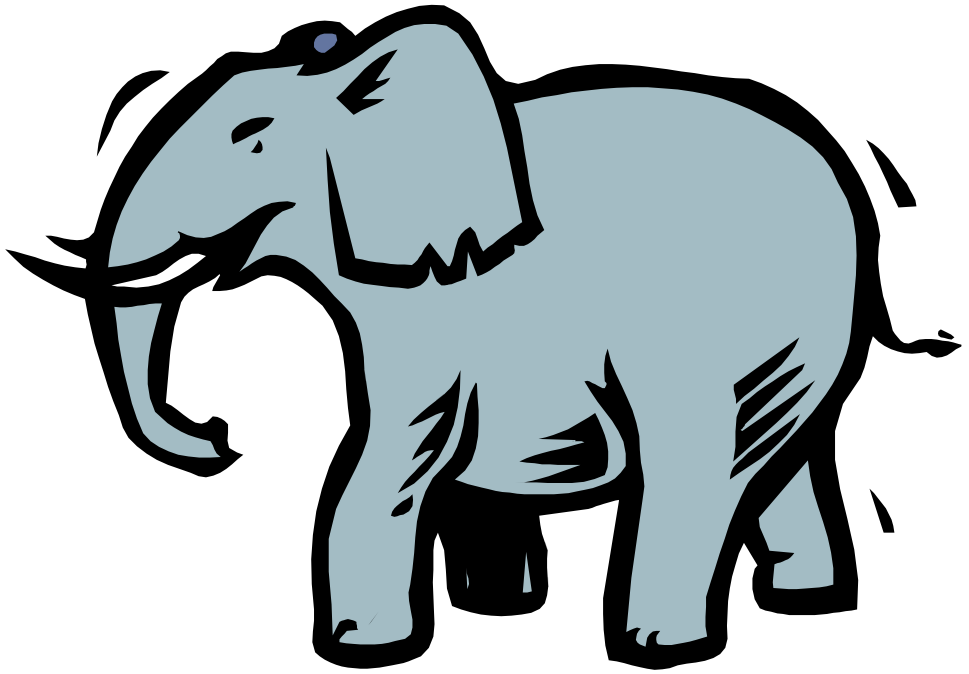
  - The **impulse-momentum theorem** states that when a net force is applied to an object over a certain time interval, the force will cause a change in the object's momentum. A

$$\mathbf{F}\Delta t = \Delta\mathbf{p} = m\mathbf{v}_\mathbf{f} - m\mathbf{v}_\mathbf{i}$$

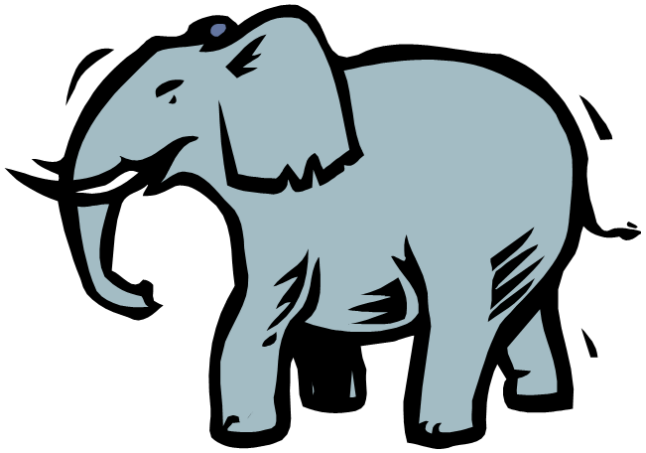
force × time interval = change in momentum

Sample Problem

- A 3000kg elephant is chasing a 1 kg squirrel across the road at a velocity of 5 m/s to the west. What is the momentum of the elephant? If the squirrel is running at 7 m/s west what is its momentum?



Solve the Problem



- Momentum of the **elephant**
  - p = mv = (3000 kg)(5m/s)= 15000 kg.m/s West

- Momentum of the **squirrel**
  - p=mv= (1kg) (7m/s) = 7 kgm/s Wes

➢ Momentum is Conserved

The Law of Conservation of Momentum:

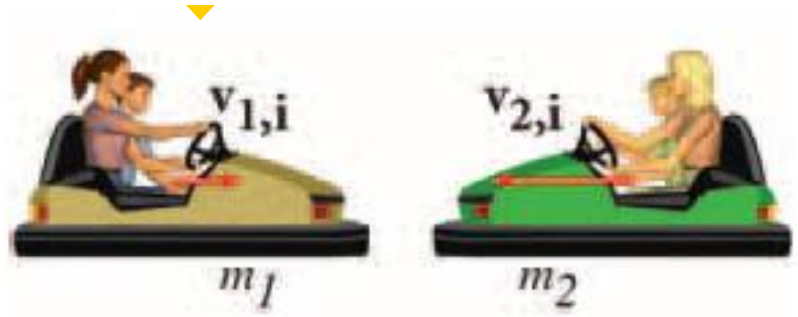
The total momentum of all objects interacting with one another remains constant regardless of the nature of the forces between the objects.

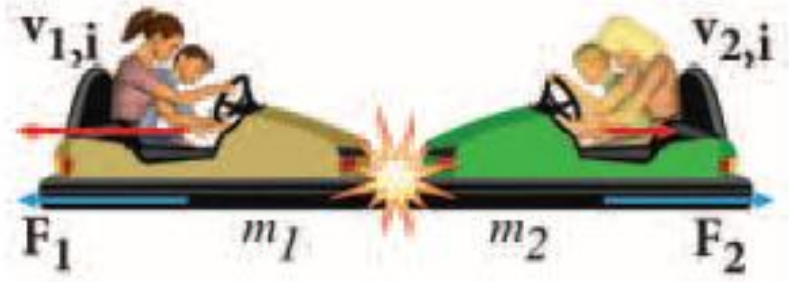
$$m_1\mathbf{v_{1,i}} + m_2\mathbf{v_{2,i}} = m_1\mathbf{v_{1,f}} + m_2\mathbf{v_{2,f}}$$

total initial momentum = total final momentum

Momentum is Conserved, *continued*

- Newton's third law leads to conservation of momentum
- During the collision, the force exerted on each bumper car causes a change in momentum for each car.
- The total momentum is the same before and after the collision.





➢ Collisions

1. Elastic Collision

A collision in which the total momentum and the total kinetic energy are conserved is called an **elastic collision.**

- **Momentum and Kinetic Energy Are Conserved in an Elastic Collision**

$$m_1\mathbf{v_{1,i}} + m_2\mathbf{v_{2,i}} = m_1\mathbf{v_{1,f}} + m_2\mathbf{v_{2,f}}$$

$$\frac{1}{2}m_1v_{1,i}^2 + \frac{1}{2}m_2v_{2,i}^2 = \frac{1}{2}m_1v_{1,f}^2 + \frac{1}{2}m_2v_{2,f}^2$$

➢ Collisions

2. Perfectly inelastic collision

A collision in which two objects stick together after colliding and move together as one mass is called a **perfectly inelastic collision.**

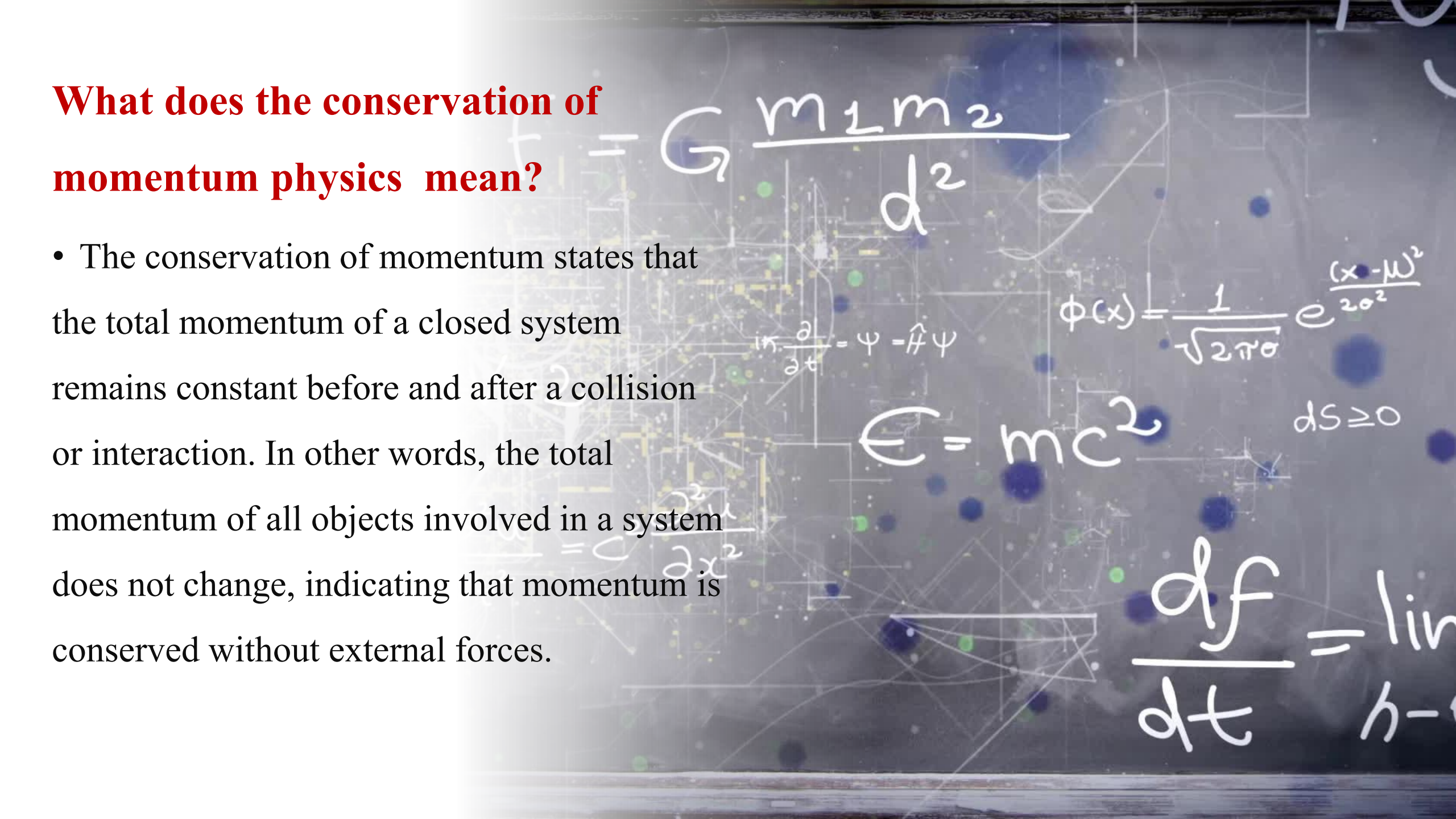
- Conservation of momentum for a perfectly inelastic collision:

$$m_1\mathbf{v_{1,i}} + m_2\mathbf{v_{2,i}} = (m_1 + m_2)\mathbf{v_f}$$

total initial momentum = total final momentum

What does the conservation of momentum physics mean?

- The conservation of momentum states that the total momentum of a closed system remains constant before and after a collision or interaction. In other words, the total momentum of all objects involved in a system does not change, indicating that momentum is conserved without external forces.



Assignment: Real-Life Applications :-

1. Linear Momentum & Its Equation
2. Impulse-Momentum Theorem
3. Conservation of Momentum
4. Elastic & Inelastic Collisions