

PH205: Math Method of Physics

Lecture 2: Math Method of Physics

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1 Newton's First Law: The Law of Inertia

Newton's first law states that an object will remain at rest or in uniform motion in a straight line unless acted upon by an external force. This property of an object to resist changes in its state of motion is called **inertia**.

Key Point!

An object's velocity, \vec{v} , is constant if and only if the net force, $\sum \vec{F}$, acting on it is zero. Mathematically:

$$\sum \vec{F} = 0 \iff \frac{d\vec{v}}{dt} = 0$$

2 Newton's Second Law: Force and Acceleration

This is the most famous of the three laws. It provides a quantitative relationship between force, mass, and acceleration.

Definition: Force

In physics, a force is an influence that can change the motion of an object. A force can cause an object with mass to change its velocity (e.g., moving from a state of rest), i.e., to accelerate.

The law is expressed by the formula:

$$\vec{F}_{net} = m\vec{a}$$

Where:

- \vec{F}_{net} is the net force vector.
- m is the mass of the object (a scalar).
- \vec{a} is the acceleration vector.

Example

A 10 kg box is pushed on a frictionless surface with a horizontal force of 50 N. What is its acceleration?

Using Newton's second law:

$$a = \frac{F}{m} = \frac{50 \text{ N}}{10 \text{ kg}} = 5 \text{ m/s}^2$$

3 Newton's Third Law: Action and Reaction

For every action, there is an equal and opposite reaction.

Theorem: Action-Reaction Pairs

If object A exerts a force \vec{F}_{AB} on object B, then object B simultaneously exerts a force \vec{F}_{BA} on object A, and the two forces are equal in magnitude and opposite in direction:

$$\vec{F}_{AB} = -\vec{F}_{BA}$$

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