Newton's Laws of Motion | Definition, and Examples

Newton (1642-1727) researched and developed ideas for the movement of Galileo (1564-1642). He published his laws in a book in Latin "philosophiae naturalis principia mathematica" which means, "the mathematical principles of natural philosophy".

Newton's laws of motion are applicable for only low speed as compared to the speed of light. These Newton's laws of motion establish the relationship between the motion of the body, mass, and force.

Relativistic mechanics developed by Albert Einstein can be used for fast-moving objects. It can be applied to atomic particles

Newton's first law of motion

"A body remains at rest or continues to move with a constant velocity until an external force acts on the body". This is also called the "law of inertia".

What is Inertia?

It is the quality of the body that resists changes in the state of exercise and rest. Inertia is directly proportional to the mass of the body

Examples:

- A dropped ball continues falling until some force stops it
- If you let go of the moving cart, it will continue to rotate (eventually it will stop due to friction).

- Apples lying on the table do not move spontaneously

Types of frame of reference

- Inertial frame of reference
- The non-inertial frame of reference

Inertial frame of reference

The unaccelerated coordinate system is called the inertial coordinate system. Newton's laws are valid for this frame. Earth is considered to be the inertial frame of reference

The non-inertial frame of reference

The accelerated frame of reference is called a non-inertial frame of reference. Newton's laws are not valid for this frame of reference.

Newton's second law of motion

"When a force is applied on a body, acceleration is produced in its direction. This acceleration is directly proportional to the force and inversely proportional to the mass.".

Mathematically

$$F=ma$$

Unit of force

The SI unit of force is Newton.

$$1N=1kg\times1ms\text{-}2$$

The force, which produces an acceleration of 1 ms-2 in a body of mass 1kg, is 1 Newton

Dimension of force

$$[MLT^{-2}]$$

Examples:

- Trucks take longer to stop than cars.
- Being hit by fast-moving baseball is more painful than slow-moving baseball. The mass of each sphere is the same, but the force depends on the acceleration.
- It takes more effort to move a heavy box than a light one.

Newton's third law of motion

"Action and reaction are equal in magnitude but opposite in direction"
or

"Every action has an equal and opposite reaction"

When body ‘A’ exerts a force on body ‘B’, it is called the action of body ‘A’ on body ‘B’. The body ‘B’ exerts the force on body ‘A’, which is called reaction.

$F_{AB}=-F_{BA}$

Action and reaction never act on the same body.

Examples

- Flight motion of a bird
- A person walks on the ground