

# Physics

## Classical Mechanics

### Newton's Laws of Motion

Published in his 1687 paper Principia, these laws describe the motion of objects and continue to serve as the foundations of classical mechanics in the modern day.

1. An object remains at rest or in motion at a constant speed unless acted on by an external force. (aka the principle of inertia)
2. The resultant force acting on a body is the rate of change of the momentum of the object:

$$F = \frac{dP}{dt} = m\mathbf{a}$$

3. Every action results in an equal and opposite reaction. This can also be used to show the conservation of linear momentum.

### Frame of Reference

A coordinate system whose origin and basis are specified in space.

A frame of reference itself can be in motion, for example when considering an object on the Earth's surface as "stationary" the frame of reference in which we are thinking is moving with the same velocity as that object when compared to any other object in space. It would be considered as moving at the same velocity as the Earth's surface in a different frame of reference with the sun as the origin.

*Inertial Reference Frame* - A reference frame in which objects obey the principle of inertia; ie. the frame itself is moving at a constant velocity in relation to any other inertial reference frame. The Earth's surface is a good approximation of an inertial reference frame which we are accustomed to thinking in terms of.

*Non-Inertial Reference Frame* - It is accelerating in some way; objects defined as stationary / moving at a constant velocity with respect to the frame are therefore also accelerating in relation to any other inertial reference frame without the need of any external force and thus violate the principle of inertia.

TODO: Rotating frame of reference

## Special Relativity

*Spacetime* - A 4-dimensional representation of the universe as 3D space + time. Classical mechanics treats time as a uniform quantity throughout the universe with a constant rate of passage.

TODO: Minkowski space

TODO: Michelson-Morsley experiment and the aether

TODO: FitzGerald Lorentz

Special relativity is a theory published in 1905 (On the Electrodynamics of Moving Bodies) by Albert Einstein, modelling motion through spacetime when gravitational and quantum effects are negligible.

In special relativity, time becomes relative to the velocity of particles

*Postulate* - Something assumed as true in a theory.

It is based on 2 postulates:

1. The laws of physics are invariant in all inertial frames of reference. This is known as the principle of relativity.
2. The speed of light is the same for all observers, regardless of all motion.

TODO: Lorentz transformation and factor

TODO:

- Feynman or University Physics
- Lagrangian & Hamiltonian mechanics