

# Newtonian Mechanics [mhn1]

## Space and Time

- Absolute space is 3-dimensional, homogeneous, and isotropic; the (Euclidean) metric is independent of the objects present in space.
- Absolute time is homogeneous.

Relativistic mechanics introduces major modifications regarding the properties of space and time.

## Galilei's Principle of Relativity

There exist *inertial* coordinate systems:

- The laws of mechanics are the same in all inertial coordinate systems (invariance under Galilean transformations).
- All coordinate systems in uniform rectilinear motion with respect to an inertial coordinate system are themselves inertial.

The laws of relativistic mechanics are invariant under Lorentz transformations. In general relativity, the restriction to inertial systems is removed.

## Newton's Laws of Dynamics

1. A body remains at rest or in uniform rectilinear motion unless acted upon by a force.
2. A body acted upon by a force moves in such a manner that the time rate of change of momentum equals the force exerted on it:  $d\mathbf{p}/dt = \mathbf{F}$ .
3. If two bodies exert forces on each other, these forces are equal in magnitude and opposite in direction (action-reaction pair of forces).

Newton's second law states the (deterministic) relation between *cause* and *effect*. Any deterministic forecast depends on precise knowledge of initial conditions and forces.

The absolute determinism of Newtonian mechanics were subsequently undermined from two sides: by *chaos theory* and by *quantum mechanics*.