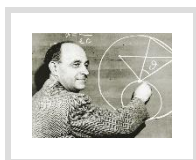


**Physics**, [science](#) that deals with the structure of matter and the interactions between the fundamental [constituents](#) of the [observable universe](#). In the broadest sense, physics (from the Greek *physikos*) is concerned with all aspects of nature on both the macroscopic and submicroscopic levels. Its scope of study [encompasses](#) not only the behaviour of objects under the action of given forces but also the nature and origin of gravitational, electromagnetic, and [nuclear force](#) fields. Its ultimate objective is the formulation of a few [comprehensive](#) principles that bring together and explain all such [disparate](#) phenomena.

*[\(Read Einstein's 1926 Britannica essay on space-time.\)](#)*

Physics is the basic [physical science](#). Until rather recent times *physics* and *natural philosophy* were used interchangeably for the science whose aim is the discovery and formulation of the fundamental laws of nature. As the modern sciences developed and became increasingly specialized, physics came to denote that part of physical science not included in [astronomy](#), [chemistry](#), [geology](#), and [engineering](#). Physics plays an important role in all the natural sciences, however, and all such fields have branches in which physical laws and measurements receive special emphasis, bearing such names as [astrophysics](#), [geophysics](#), [biophysics](#), and even [psychophysics](#). Physics can, at base, be defined as the science of [matter](#), [motion](#), and [energy](#). Its laws are typically expressed with economy and precision in the language of [mathematics](#).

Both experiment, the observation of phenomena under conditions that are controlled as precisely as possible, and theory, the formulation of a unified [conceptual](#) framework, play essential and complementary roles in the advancement of physics. Physical experiments result in measurements, which are compared with the outcome predicted by theory. A theory that reliably predicts the results of experiments to which it is applicable is said to embody a law of physics. However, a law is always subject to modification, replacement, or restriction to a more limited domain, if a later experiment makes it necessary.



[Physics and Natural Law](#)

The ultimate aim of physics is to find a unified set of laws governing matter, motion, and energy at small (microscopic) subatomic distances, at the human (macroscopic) scale of everyday life, and out to the largest distances (e.g., those on the extragalactic scale). This ambitious goal has been realized to a notable extent. Although a completely unified theory of physical phenomena has not yet been achieved (and possibly never will be), a remarkably small set of fundamental physical laws appears

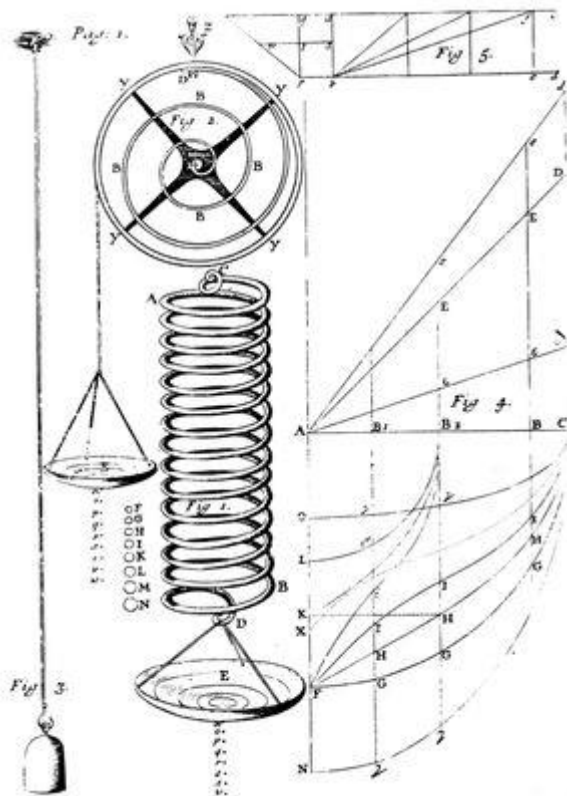
able to account for all known phenomena. The body of physics developed up to about the turn of the 20th century, known as classical physics, can largely account for the motions of macroscopic objects that move slowly with respect to the [speed of light](#) and for such phenomena as [heat](#), [sound](#), [electricity](#), [magnetism](#), and [light](#). The modern developments of [relativity](#) and [quantum mechanics](#) modify these laws insofar as they apply to higher speeds, very massive objects, and to the tiny elementary constituents of matter, such as [electrons](#), [protons](#), and [neutrons](#).

## The scope of physics

The traditionally organized branches or fields of classical and modern physics are [delineated](#) below.

Get a Britannica Premium subscription and gain access to exclusive content. [Subscribe Now](#)

## [Mechanics](#)



### [illustration of Robert Hooke's law of elasticity of materials](#)

Illustration of Hooke's law of elasticity of materials, showing the stretching of a spring in proportion to the applied force, from Robert Hooke's *Lectures de Potentia Restitutiva* (1678).[\(more\)](#)

Mechanics is generally taken to mean the study of the motion of objects (or their lack of motion) under the action of given forces. Classical mechanics is sometimes considered a branch of applied mathematics. It consists of [kinematics](#), the description of motion, and [dynamics](#), the study of the action of forces in producing either motion or [static equilibrium](#) (the latter [constituting](#) the science of [statics](#)). The 20th-century subjects of [quantum mechanics](#), crucial to treating the structure of matter, [subatomic particles](#), [superfluidity](#), [superconductivity](#), [neutron stars](#), and other major phenomena, and [relativistic mechanics](#), important when speeds approach that of light, are forms of mechanics that will be discussed later in this section.

In classical mechanics the laws are initially formulated for point particles in which the dimensions, shapes, and other [intrinsic](#) properties of bodies are ignored. Thus in the first approximation even objects as large as [Earth](#) and the [Sun](#) are treated as pointlike—e.g., in calculating planetary orbital motion. In rigid-body [dynamics](#), the extension of bodies and their mass distributions are considered as well, but they are imagined to be incapable of [deformation](#). The mechanics of deformable solids is [elasticity](#); [hydrostatics](#) and [hydrodynamics](#) treat, respectively, fluids at rest and in motion.

The three [laws of motion](#) set forth by [Isaac Newton](#) form the foundation of classical mechanics, together with the recognition that forces are directed quantities ([vectors](#)) and combine accordingly. The first law, also called the [law of inertia](#), states that, unless acted upon by an external [force](#), an object at rest remains at rest, or if in motion, it continues to move in a straight line with constant [speed](#). Uniform motion therefore does not require a cause. Accordingly, mechanics concentrates not on motion as such but on the change in the state of motion of an object that results from the net [force](#) acting upon it. Newton's second law equates the net force on an object to the rate of change of its momentum, the latter being the product of the mass of a body and its velocity. Newton's third law, that of action and reaction, states that when two particles interact, the forces each [exerts](#) on the other are equal in magnitude and opposite in direction. Taken together, these mechanical laws in principle permit the determination of the future motions of a set of particles, providing their state of motion is known at some instant, as well as the forces that act between them and upon them from the outside. From this deterministic character of the laws of classical mechanics, profound (and probably incorrect) philosophical conclusions have been drawn in the past and even applied to human history.

Lying at the most basic level of physics, the laws of mechanics are characterized by certain [symmetry](#) properties, as [exemplified](#) in the aforementioned symmetry between action and reaction forces. Other symmetries, such as the invariance (i.e., unchanging form) of the laws under reflections and rotations carried out in [space](#), reversal of time, or transformation to a different part of space or to a different epoch of time, are present both in classical mechanics and in relativistic mechanics, and with certain restrictions, also in quantum mechanics. The symmetry properties of the theory can be shown to have as mathematical consequences basic principles known as [conservation laws](#), which assert the constancy in time of the values of certain physical quantities under prescribed conditions. The conserved quantities are the most important ones in physics; included among them are mass and energy (in relativity theory, mass and energy are equivalent and are conserved together), [momentum](#), [angular momentum](#), and [electric charge](#).