Motion, Laws of

How to Cite This Article

Newton's laws of motion are the three most fundamental natural laws of classical mechanics. Sir Isaac Newton stated them in his book *Principia* (1686). Taken together, Newton's three laws of motion underlie all interactions of force, matter, and motion except those involving relativistic and quantum effects.

Newton's first law of motion is also known as the law of inertia, which states that any object in a state of rest or of uniform linear motion tends to remain in such a state unless acted upon by an unbalanced external force. In effect, this is a definition of equilibrium; the branch of physics that treats equilibrium situations is statics. The tendency for matter to maintain its state of motion is known as inertia.

Newton's second law of motion, the most important and useful of the three, establishes a relationship between the unbalanced force applied to an object and the resultant acceleration of the object. This relationship states that an unbalanced force acting on an object produces an acceleration that is in the direction of the force, directly proportional to the force, and inversely proportional to the mass of the object. In other words, force equals mass times acceleration, or $F = ma$. Thus, a given force will accelerate an object of small mass more rapidly than it will an object of larger mass. Similarly, doubling the applied force produces twice the acceleration of an object of arbitrary mass.

According to Newton's third law of motion, which is also known as the principle of action and reaction, every action (or force) gives rise to a reaction (or opposing force) of equal strength but opposite direction. In other words, every object that exerts a force on another object is always acted upon by a reaction force. The recoil of a gun, the thrust of a rocket, and the rebound of a hammer from a struck nail are examples of motion due to reaction forces.

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