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*This article is about the concept in astronomy, physics and chemistry. For other uses, see* [*Matter (disambiguation)*](http://en.wikipedia.org/wiki/Matter_%28disambiguation%29)*.*

The term **matter** traditionally refers to the substance that objects are made of.[[1]](http://en.wikipedia.org/wiki/Matter#cite_note-mcgrawhill-0) One common way to identify this "substance" is through its properties: for example, *matter* is anything that has both [mass](http://en.wikipedia.org/wiki/Mass) and [volume](http://en.wikipedia.org/wiki/Volume).[[2]](http://en.wikipedia.org/wiki/Matter#cite_note-Mongillo-1)

A more general view is that bodies are made of *several* substances, and the properties of matter (among them, mass and volume) are determined not only by the substances themselves, but by how they interact. In other words, **matter** is made up of interacting *"building blocks"*,[[3]](http://en.wikipedia.org/wiki/Matter%22%20%5Cl%20%22cite_note-Davies2-2)[[4]](http://en.wikipedia.org/wiki/Matter#cite_note-Hooft-3) the so-called *particulate theory of matter*.[[5]](http://en.wikipedia.org/wiki/Matter#cite_note-particulate-4)

Underlying the notion of matter are some age-old, seemingly [simple questions](http://en.wikipedia.org/wiki/Simplicity): "What happens when a substance is cut in half over and over again? Is there a limit to how small a piece of substance you can have?"[[6]](http://en.wikipedia.org/wiki/Matter#cite_note-Johnson-5) "When the pieces of substance are small enough, is there only a small number of different building blocks from which any substance is made?"[[7]](http://en.wikipedia.org/wiki/Matter#cite_note-Allday-6)

Our growing understanding of matter can be seen as an evolution in just *what* the basic building blocks are, and in how they interact. For example, for Isaac Newton in the early 18th century, matter was formed "in solid, massy, hard, impenetrable, movable particles", which were "even so very hard as never to wear or break in pieces"[[8]](http://en.wikipedia.org/wiki/Matter#cite_note-Newton-7) The primary or "real" qualities of matter were amenable to mathematical description (a kind of "billiard ball" model), unlike secondary qualities such as color or taste.[[8]](http://en.wikipedia.org/wiki/Matter#cite_note-Newton-7) In the 19th century, matter was what is made up of *atoms*, at that time thought of as irreducible constituents of matter interacting to form [molecules](http://en.wikipedia.org/wiki/Molecules).[[9]](http://en.wikipedia.org/wiki/Matter#cite_note-Wenham-8) Subsequently, matter was seen as made up of electrons, protons and neutrons interacting to form atoms. Today we know even protons and neutrons are not indivisible, but the particulate theory still applies. Just the "building blocks" have changed; matter is constructed of more microscopic building blocks, namely [quarks and leptons](http://en.wikipedia.org/wiki/Matter#Quarks_and_leptons_definition) interacting to form (among other things) [nucleons](http://en.wikipedia.org/wiki/Nucleons).[[10]](http://en.wikipedia.org/wiki/Matter#cite_note-Povh1-9)

During this evolution of the building blocks over time, each generation has encompassed its predecessor, and so engenders the same properties of matter explored in the earlier epoch. However, the evolution of building blocks has followed probes of the properties of matter to smaller and smaller scales of length, and to higher and higher energies and densities; the new building blocks predict properties in regimes not previously accessible in the days of the earlier building blocks. The change in building blocks means that although matter still may be made up of atoms and molecules (because they are made from leptons and quarks), matter is more general than this, and can be made up of assemblies of leptons and quarks that are *not* atoms or molecules, such as a [quark-gluon plasma](http://en.wikipedia.org/wiki/Quark-gluon_plasma), the form of matter believed to have existed in the first few microseconds of the "[big bang](http://en.wikipedia.org/wiki/Big_bang)", and to exist in [neutron stars](http://en.wikipedia.org/wiki/Neutron_star).[[11]](http://en.wikipedia.org/wiki/Matter#cite_note-Martin-10)

The quark-lepton building blocks interact through a number of [fundamental forces](http://en.wikipedia.org/wiki/Fundamental_forces), and are described by the [Standard Model](http://en.wikipedia.org/wiki/Standard_Model) of particle physics (gravity so far included only classically; see [quantum gravity](http://en.wikipedia.org/wiki/Quantum_gravity) and [graviton](http://en.wikipedia.org/wiki/Graviton)).[[12]](http://en.wikipedia.org/wiki/Matter#cite_note-Allday2-11) Interactions are mediated by [field quanta](http://en.wikipedia.org/wiki/Field_quanta) or [force carriers](http://en.wikipedia.org/wiki/Force_carriers), of which the [W-boson](http://en.wikipedia.org/wiki/W-boson) and the [photon](http://en.wikipedia.org/wiki/Photon) are examples.[[13]](http://en.wikipedia.org/wiki/Matter#cite_note-MatterField-12) The interactions are not themselves building blocks, and consequently neither are their quanta. As one consequence, energy cannot always be related to matter: for example, photons possess energy (see [Planck relation](http://en.wikipedia.org/wiki/Planck_relation)); however, photons commonly are distinguished from matter.[[14]](http://en.wikipedia.org/wiki/Matter#cite_note-PhotonsMatter-13) Also, mass cannot always be related to matter: certain particles are massive, such as the W-boson, but are not matter. Although the field quanta by themselves are not matter, in conjunction with a complex of building blocks like an atom or a [hadron](http://en.wikipedia.org/wiki/Hadron), they contribute to the invariant mass of the combination, for example, through a binding energy. [[15]](http://en.wikipedia.org/wiki/Matter#cite_note-Tipler0-14)[[16]](http://en.wikipedia.org/wiki/Matter#cite_note-Spitzer-15)

Matter is commonly said to exist in four [*states*](http://en.wikipedia.org/wiki/State_of_matter) (or [*phases*](http://en.wikipedia.org/wiki/Phase_%28matter%29)): [solid](http://en.wikipedia.org/wiki/Solid), [liquid](http://en.wikipedia.org/wiki/Liquid), [gas](http://en.wikipedia.org/wiki/Gas) and [plasma](http://en.wikipedia.org/wiki/Plasma_%28physics%29). However, advances in experimental technique have realized other phases, previously only theoretical constructs, such as [Bose–Einstein condensates](http://en.wikipedia.org/wiki/Bose%E2%80%93Einstein_condensate) and [Fermionic condensates](http://en.wikipedia.org/wiki/Fermionic_condensate). A focus on an elementary-particle view of matter also leads to new phases of matter, such as the [quark-gluon plasma](http://en.wikipedia.org/wiki/Quark-gluon_plasma).[[17]](http://en.wikipedia.org/wiki/Matter#cite_note-RHIC-16)

In [physics](http://en.wikipedia.org/wiki/Physics) and [chemistry](http://en.wikipedia.org/wiki/Chemistry), matter and [energy](http://en.wikipedia.org/wiki/Energy) exhibit both [wave](http://en.wikipedia.org/wiki/Wave)-like and [particle](http://en.wikipedia.org/wiki/Subatomic_particle)-like properties, the so-called [wave-particle duality](http://en.wikipedia.org/wiki/Wave-particle_duality) or [matter wave](http://en.wikipedia.org/wiki/Matter_wave). In this connection, physicists speak of *matter fields*, and speak of particles as "quantum excitations of a mode of the matter field".[[18]](http://en.wikipedia.org/wiki/Matter#cite_note-Davies-17)[[19]](http://en.wikipedia.org/wiki/Matter#cite_note-Weinberg-18)[[20]](http://en.wikipedia.org/wiki/Matter#cite_note-Masujima-19)

In the realm of [cosmology](http://en.wikipedia.org/wiki/Cosmology), extensions of the term *matter* are invoked to include [dark matter](http://en.wikipedia.org/wiki/Matter#Dark_matter) and [dark energy](http://en.wikipedia.org/wiki/Matter#Dark_energy), concepts introduced to explain some odd phenomena of the [observable universe](http://en.wikipedia.org/wiki/Observable_universe), such as the [galactic rotation curve](http://en.wikipedia.org/wiki/Galactic_rotation_curve). These exotic forms of "matter" are not formed of the same building blocks that make up ordinary matter.[[21]](http://en.wikipedia.org/wiki/Matter#cite_note-Majumdar-20)