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States of Matter

Matter can exist in solid, liquid, and gaseous form, as well as in the form of a plasma

? ◆ STATES OF MATTER

1761 ◆ CHANGES OF STATE

1798 ◆ HEAT, ATOMIC THEORY OF

Matter is composed of atoms, and the bulk form of the matter depends on how those atoms are arranged and how they interact with one another. In general, you can think of matter as coming in three forms—solid, liquid, and gas.

A *gas* will expand to fit both the size and the shape of any container into which it is put. If you could look at gases at the atomic level, you would see the atoms zipping around, colliding with one another and with the walls of the container, but not interacting to any great degree. If you expand or shrink the container, the gas molecules spread themselves evenly through the new volume. The KINETIC THEORY of gases explains how the atomic properties of a gas can be related to its macroscopic properties such as temperature and pressure

Unlike a gas, a *liquid* keeps a constant volume, though, it too will assume the shape of its container below its surface. The easiest way to picture a liquid in terms of atoms is to imagine the atoms in contact with one another, but free to roll around, rather like marbles in a jar. If you pour a liquid into a container, the atoms will roll around and assume its shape, but they will not expand to fill any new volume.

A *solid* has its own shape and will not adjust to the shape of a container. To think of a solid at the atomic level, imagine the atoms locked together by CHEMICAL BONDS, so that their relationship to one another is fixed. This locking together can be in a rigid, lattice arrangement (as in crystals) or in a more disordered structure, as in plastics, in which molecules are arranged like the intermingling strands of spaghetti in a bowl.

The states of matter described above are the traditional three. There is, however, another state in which matter can exist, one which scientists generally think of as a fourth state of matter. This is the *plasma*. In a plasma, electrons have been torn from their atoms, but remain in the material. Thus, a plasma is electrically neutral—there are as many positive charges as negative—but the positive and negative charges are free to move independently. We can have a plasma in which only a few electrons are removed from their atoms (as in a fluorescent light bulb), or in which all the electrons are torn loose (as in the interior of the Sun).

At extremely low temperatures, the velocities of atoms become very small and so are known to a high degree of accuracy. According to HEISENBERG'S UNCERTAINTY PRINCIPLE, their positions become very uncertain. When the uncertainty in the position of an atom becomes as large as the group of atoms to which it belongs, that group starts to behave as a single entity. Such groups of atoms are called *Bose–Einstein condensates*, and can be regarded as a fifth state of matter.