Topic Page: low-temperature physics

Summary Article: **low-temperature physics**
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science concerned with the production and maintenance of temperatures much below normal, down to almost absolute zero, and with various phenomena that occur only at such temperatures. The temperature scale used in low-temperature physics is the Kelvin temperature scale, or absolute temperature scale, which is based on the behavior of an idealized gas (see gas laws; kinetic-molecular theory of gases). Low-temperature physics is also known as cryogenics, from the Greek meaning "producing cold." Low temperatures are achieved by removing energy from a substance. This may be done in various ways. The simplest way to cool a substance is to bring it into contact with another substance that is already at a low temperature. Ordinary ice, dry ice (solid carbon dioxide), and liquid air may be used successively to cool a substance down to about 80 degrees Kelvin (about −190 degrees Celsius). The heat is removed by conduction, passing from the substance to be cooled to the colder substance in contact with it. If the colder substance is a liquefied gas (see liquefaction), considerable heat can be removed as the liquid reverts to its gaseous state, since it will absorb its latent heat of vaporization during the transition. Various liquefied gases can be used in this manner to cool a substance to as low as 4.2 degrees Kelvin, the boiling point of liquid helium. If the vapor over the liquid helium is continually pumped away, even lower temperatures, down to less than 1 degrees Kelvin, can be achieved because more helium must evaporate to maintain the proper vapor pressure of the liquid helium. Most processes used to reduce the temperature below this level involve the heat energy that is associated with magnetization (see magnetism). Successive magnetization and demagnetization under the proper combination of conditions can lower the temperature to only about a millionth of a degree above absolute zero. Reaching such low temperatures becomes increasingly difficult, as each temperature drop requires finding some kind of energy within the substance and then devising a means of removing this energy. Moreover, according to the third law of thermodynamics, it is theoretically impossible to reduce a substance to absolute zero by any finite number of processes.
Superconductivity and superfluidity have traditionally been thought of as phenomena that occur only at temperatures near absolute zero, but by the late 1980s several materials that exhibit superconductivity at temperatures exceeding 100 degrees Kelvin had been found. Superconductivity is the vanishing of all electrical resistance in certain substances when they reach a transition temperature that varies from one substance to another; this effect can be used to produce powerful superconducting magnets. Superfluidity occurs in liquid helium and leads to the tendency of liquid helium to flow over the sides of any container it is placed in without being stopped by friction or gravity.

See Helden, A. C. , The Coldest Spot on Earth (1989).

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