

Thermometers and Temperature

Temperature, as we learned previously, is the average kinetic energy of the particles in a substance. For our purposes it's the measure of how hot or cold something is. For much of human history it was a subjective observation based on our own experiences. A parent may have placed the back of their hand on a child's forehead to determine if they had a fever, or we might have put gloves on when we noticed our hands became cold during winter. The word temperature hadn't been developed yet, so it was referred to as *sensible heat*.



However, as scientific knowledge progressed in Europe, the need for more accurate and precise temperature measurements resulted in a number of scientists creating their own devices to measure temperature.

The first devices lacked any numerical scale on them, and were more accurately called thermoscopes. These early instruments responded to changes in density of air and liquids caused by their expansion and contraction as they were heated and cooled. This caused a rising and falling of glass spheres filled with slightly differing densities of alcohol as in the device seen at left created by Galileo.

The word thermometer (in its French form) first appeared in 1624 and the first modern style thermometer with a scale on it was made about 1654 by Ferdinando de' Medici, Grand Duke of Tuscany. It was a sealed tube containing alcohol that rose and fell with the temperature.

Many different scientists made thermometers using various scales of their own design. A standard scale was suggested by Christiaan Huygens in 1665 based on the freezing and boiling of water. It wasn't until 1724 when German physicist Daniel Gabriel Fahrenheit produced a mercury thermometer that had a more precise scale and could be reliably reproduced that one temperature scale was adopted. This scale was in widespread use in most English speaking countries until the 1970's.

In 1742, Swedish astronomer Anders Celsius proposed a scale with zero for water's boiling point and 100 degrees for its freezing point. It was eventually switched around because it made more sense to do so. This scale is used in scientific work and in all countries that have switched to the metric system.

However the official metric unit of temperature is the Kelvin, developed by British physicist William Thomson, Baron Kelvin in 1848. This scale of temperature is known as the *Absolute Temperature Scale* since its zero point is absolute zero, the theoretical temperature when particles of matter have reached their lowest possible thermal energy.

The Absolute scale begins at absolute zero and is assigned a value of zero Kelvin (0 K). No degree symbol or tag is used for temperatures on this scale. At 273 K water freezes and at 373 K water boils. The Celsius scale has the freezing point of water for its zero point and 100 ° for water's boiling point. Absolute zero on the Celsius scale is -273 °C. The Fahrenheit scale uses 32°F for water's freezing point and 212 °F for water's boiling point.

The three temperature scales you need to know are Fahrenheit, Celsius and Absolute. Converting temperatures between the Celsius and Absolute scales is easy since the size of a Celsius degree and a Kelvin are the same. Converting from Celsius to Fahrenheit, or Fahrenheit to Celsius requires some mathematical adjustments since a Fahrenheit degree is smaller than a Celsius degree.

To Convert from	Do this
°F to °C	$^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$
°C to °F	$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$
K to °C	$^{\circ}\text{C} = \text{K} - 273$
°C to K	$\text{K} = ^{\circ}\text{C} + 273$

Below is a diagram comparing some useful and familiar temperatures between the three scales.

