Temperature is defined as the kinetic energy (motion) of particles. Particles with more energy move faster, which we feel as heat. Thus, when we measure how hot something is, we measure its kinetic energy.

Some temperature scales, like the Celsius scale and Fahrenheit scale, have been designed to correspond with properties of common substances. These are called **empirical scales**. The Celsius scale makes reference to the properties of water by taking the boiling point of water as one point and the freezing point of water as another.

To better represent this property of matter being measured scientifically, **absolute scales** of thermodynamic temperature are used. Thermodynamic temperature is a measure of temperature that is completely independent of the physical properties of any one substance; rather, it is a measure of how much kinetic energy is present in the particles of a matter. In the absence of kinetic energy where no particles are in motion, the temperature is 0. In the absolute scale, this is the lowest possible temperature and is called absolute zero. Since the measurements in absolute scales do not have negative values, they are useful for scientific calculations. The Kelvin scale and the Rankine scale are both absolute scales of thermodynamic temperature.

Empirical Scales

The Celsius scale is used for measurements of temperature in degree Celsius (˚C). On this scale, the freezing point of water is set at 0˚C and the boiling point at 100˚C, making a difference of 100 degrees between these two reference points. The Celsius scale is adopted in most parts of the world for everyday temperature measurements.

The Fahrenheit scale uses the degree Fahrenheit (˚F) as the measuring unit of temperature. On the Fahrenheit scale, the freezing point of water is 32˚F and the boiling point is 212˚F. This puts the freezing and boiling points of water 180 degrees apart. The Fahrenheit scale is used primarily in the United States. Below are the unit conversions:

$$(^\circ C) = ((^\circ F) - 32) \times \frac{5}{9} \qquad (^\circ F) = (^\circ C) \times \frac{9}{5} + 32$$

Absolute Scales

The Kelvin scale measures temperature in kelvin (K), which is the base unit of temperature in the International System of Units. As an absolute scale, this scale does not have negative values and the lowest possible theoretical temperature is 0 K. Since the temperature difference of one kelvin is equal to one degree Celsius, the Kelvin scale is scalable to the Celsius scale.

$$(K) = (^\circ C) + 273.15$$

The Rankine scale, like the Kelvin scale, has no negative values. This scale measures temperature in degree Rankine (˚R). The Rankine scale is directly scalable to the Fahrenheit scale. It is most often used for scientific purposes in the United States, where Fahrenheit is primarily used.

$$(^\circ R) = (^\circ F) + 459.67$$

	Celsius (˚C)	Fahrenheit (˚F)	Kelvin (K)	Rankine (˚R)
Absolute Zero	-273.15˚C	-459.67˚F	0 K	0˚R
Freezing Point of Water	0˚C	32˚F	273.15 K	491.67˚R
Boiling Point of Water	100˚C	212˚F	373.15 K	671.67˚R