

# Temperature

## What is temperature?

Temperature can be a difficult property to define. In our everyday lives we use the word temperature to describe the hotness or coldness of an object. In physics, the temperature is the average kinetic energy of the moving particles in a substance.

## How is temperature measured?

Temperature is measured using a thermometer. There are different scales and standards for measuring temperature including Celsius, Fahrenheit, and Kelvin. These are discussed in more detail below.

## How does a thermometer work?

Thermometers take advantage of a scientific property called thermal expansion. Most substances will expand and take up more volume as they get hotter. Liquid thermometers have some sort of substance (this used to be mercury, but today is generally alcohol) that is enclosed in a small glass tube.

As the temperature rises, the liquid expands and fills up more of the tube. When the temperature drops, the liquid contracts and takes up less of the tube. The temperature can then be read by the lines calibrated on the side of the tube.

## Temperature Scales

There are three main temperature scales that are used today: Celsius, Fahrenheit, and Kelvin.

- Celsius - The most common temperature scale in the world is Celsius. Celsius uses the unit "degrees" and is abbreviated as °C. The scale sets the freezing point of water at 0 °C and the boiling point of water at 100 °C.
- Fahrenheit - The temperature scale most common in the United States is the Fahrenheit scale. Fahrenheit sets the freezing point of water at 32 °F and the boiling point at 212 °F.
- Kelvin - The standard unit of temperature that is most used by scientists is Kelvin. Kelvin doesn't use the ° symbol like the other two scales. When writing a temperature in Kelvin you just use the letter K. Kelvin uses absolute zero as the 0 point of its scale. It has the same increments as Celsius in that there are 100 increments between the freezing and boiling points of water.

## Converting Between Scales

Celsius and Fahrenheit

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32)/1.8$$

$$^{\circ}\text{F} = 1.8 * ^{\circ}\text{C} + 32^{\circ}$$

Celsius and Kelvin

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

$$^\circ C = K - 273.15^\circ$$

## Absolute Zero

Absolute zero is the coldest possible temperature that any substance can reach. It is equal to 0 Kelvin or -273.15 °C (-459.67°F).

## Temperature and the State of Matter

Temperature has an effect on the state of matter. Each substance of matter will go through different phases as the temperature increases including solid, liquid, and gas. One example of this is water which changes from ice (solid) to water (liquid) to vapor (gas) as the temperature increases. You can learn more about this subject at our [phases of matter](#) page.

## Interesting Facts about Temperature

- Temperature is independent of the size or quantity of an object. This is called an intensive property.
- The Fahrenheit scale is named after [Dutch](#) physicist Daniel Fahrenheit.
- Temperature is a different quantity from the total amount of thermal energy in a substance, which is dependent on the size of the object.
- Celsius was named after the Swedish astronomer Anders Celsius. Celsius was originally known as "centigrade."
- As substances approach absolute zero they can achieve some interesting properties such as superfluidity and superconductivity.