

Heat and Temperature

The concepts of heat and temperature are frequently confused or misunderstood. In our everyday experience, people talk about temperature or how “hot” things are. However, from a scientific perspective heat and temperature are quite different. Having a working knowledge of fire dynamics requires an understanding of both of these important concepts.

Heat as Energy

Heat is a form of energy, which is the capacity to perform work. Ordinarily discussion of the concept of energy and work involves mechanical examples such as lifting a weight. However, when dealing with combustion, work involves increasing the temperature of something.

There are two scientific forms of energy, potential and kinetic. Potential energy is the energy stored in an object and kinetic energy is the energy an object has due to motion (motion of the object or motion of the molecules that make up the substance). Fuel has potential energy that is released when it is oxidized (chemical energy). All substances above absolute zero (-273°C or -460°F) have thermal kinetic energy due to the vibration and movement of their molecules. In addition, substances having thermal energy will emit radiant kinetic energy in the form of electromagnetic waves (similar to light).

Temperature is a measure of the average thermal kinetic energy of the molecules in a substance. Adding heat (additional energy), causes temperature to rise.

Measuring Temperature and Heat

There are several different scales used to measure temperature. Most common are Celsius and Fahrenheit. With the Fahrenheit scale, water freezes at 32° and boils at 212° . With the Celsius scale, water freezes at 0° and boils at 100° . While the Fahrenheit scale is commonly used in day-to-day life in the United States, the Celsius scale is used in scientific work and in the rest of the world. It is not possible to measure energy in terms of its own character. It is necessary to measure the work that it does. In the case of thermal or radiant energy, work means increasing temperature.

In science, Joules are commonly used as a unit of measure for thermal energy. While the definition of a Joule is based on mechanical work, it is more useful for firefighters to think of the joule in terms of the heat required to increase the temperature of water.

4186 Joules (J) or 4.186 Kilojoules (kJ) are required to raise the temperature of one kilogram (2.2 pounds) of water 1°C . British Thermal Units (BTU) are the traditional units of thermal energy. A BTU is the energy required to raise the temperature of one pound of water 1°F . For comparison, one BTU equals just over one kJ.

