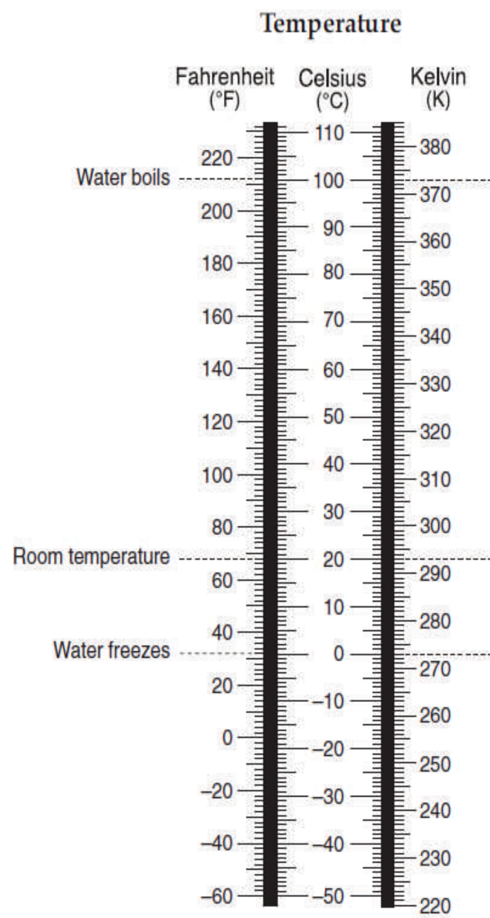
A Content Secondary Science Newsletter from the
Southern Nevada Regional Professional Development Program

Science Dissected

Temperature Conversions

Temperature is often defined as how “hot” or “cold” an object feels when we touch it. For example, a glass of iced tea may feel cold to the touch and a mug of hot cocoa may feel hot to the touch. While this is an appropriate starting point, the sense of touch serves as a qualitative indicator of temperature (see student demo on page 2). To measure temperature with precision requires a standard definition of temperature and a procedure for making measurements that quantitatively measure how “cold” or “hot” objects are.

Scientists define temperature as a measure of the average kinetic energy of the particles in a substance. The temperature of an object depends on how fast the atoms and molecules which make up the object shake, or oscillate. As an object is cooled, the oscillations of its atoms and molecules slow down. In all materials, a point is eventually reached at which all oscillations are the slowest they can possibly be and no discernable energy can be detected. The temperature which corresponds to this point is called absolute zero.



Temperature scales were established by scientists to allow them to compare their temperature measurements with those of other scientists.

Gabriel Daniel Fahrenheit (1714) developed the Fahrenheit scale. Water freezes at 32°F and boils at 212°F.

Anders Celsius (1742) introduced the “centigrade” scale. Each degree Celsius is 1/100 of the way between the temperatures of freezing (0°C) and boiling (100°C) for pure water at STP.

William Thomson, Lord Kelvin (1848) proposed an absolute scale of temperature. The coldest temperature (theoretical) is 0 K or -273.15°C. In all materials, a point is eventually reached at which all oscillations are the slowest they can possibly be. This point is called absolute zero.

The metric system (SI) units for temperature are degrees Celsius and kelvins (written °C and K).

Lab Tip: One common problem with thermometers in the science laboratory is that they get “air bubbles” or gaps in the fluid. Wearing safety goggles, use a hot plate on low setting to remove the gaps from the red alcohol thermometers. Place the bulb of the thermometer on the hot plate to warm it - watch closely, as the alcohol approaches the top of the thermometer, remove it from the heat source. Be careful - there is a lag time between removing the thermometer from the heat source and the movement of the alcohol. Once the fluid reaches the top of the thermometer the bubbles will be gone. Caution: if you overheat the thermometer it will break and spray glass and hot fluid. With a bit of practice at lower temperatures you can become proficient at thermometer repair and avoid breakage.

Temperature Conversion Calculator from WebMATH, *http://www.webmath.com/tconvert.html*

Archived Issues of Science Dissected, *http://www.rpdp.net/link.news.php?type=sciencedis*

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Temperature Conversions continued...

A temperature measurement in any of the three scales can be easily converted to another scale using the following algebraic equations:

Celsius-Fahrenheit Temperature Conversion $T_f = \frac{9}{5}T_c + 32$

Fahrenheit-Celsius Temperature Conversion $T_c = \frac{5}{9}(T_f - 32)$

Celsius-Kelvin Temperature Conversion $T_k = T_c + 273.15$

When do the numbers 95, 35, and 308 mean the exact same thing?

When they are measuring the same temperature using three different temperature scales. Verify this using the conversion equations

Given: 95°F

Convert 95°F to °C

$$T_c = \frac{5}{9}(T_f - 32)$$

$$T_c = \frac{5}{9}(95 - 32)$$

$$T_c = \frac{5}{9}(63) \text{ (multiply 63 by 5, then divide by 9)}$$

$$T_c = 35°C$$

Convert 35°C to K

$$T_k = T_c + 273.15$$

$$T_k = 35 + 273.15$$

$$T_k = 308\text{K}$$

Quick conversions verify that 95°F is the same temperature as 35°C is the same temperature as 308K. ***As with all measurements, numbers without units have no meaning!***

Student Demo

Prepare two containers of water at different temperatures, one cold water (~10°C) and one hot water (~30°C). With the students in pairs, have one place his hand in the warm water and the other student place his hand in the cold water. Instruct the students to not comment on the water temperature they put their hands in. After a short time, instruct the students to remove their hands from the water and grab hold of a metal rod that is at room temperature. Ask the students to describe the temperature of the rod. It is interesting to hear the students' interpretation of the temperature of the rod.

FYI

The kelvin (K) temperature scale is an extension of the degree Celsius scale (°C). A change of 1 degree on the Celsius scale corresponds to a change of 1 on the kelvin scale.

Example: Given temperatures: 2°C, 3°C

Converting these to kelvin using the equation yield temperatures of 275K and 276K

Here we are looking at the ***difference in temperature not the temperature***. 2°C is a mildly cool temperature (36°F) while 2K is an unbelievably cold temperature (-456°F)!