3.2: Temperature Scales I

In everyday practice, we use either the Celsius or the Fahrenheit temperature scales, depending on what we are used to, or the fashion of the day, or what our Government tells us we should be using. In the Fahrenheit scale, the freezing point of water is 32 ^{o}F and the boiling point is 212 ^{o}F, so that there are 180 F^{o} between the two fixed points. In the Celsius scale, the freezing point of water is 0 ^{o}C and the boiling point is 100 ^{o}C, so that there are 100 C^{o} between the two fixed points. (When Celsius originally introduced his scale, he set the temperature of boiling water as 0, and the temperature of melting ice as 100. That was reversed within a few years!) The Celsius scale was formerly called "the" centigrade scale, but presumably any scale with 100 degrees between two fixed points could be called a centigrade scale, so we now call it (or are supposed to call it) the Celsius scale.

Conversion is obviously by

$$\mathrm{F} = 1.8\mathrm{C} + 32 \tag{3.2.1}$$

and

$$\mathrm{C} = \frac{\mathrm{F} - 32}{1.8} = \frac{5}{9}(\mathrm{F} - 32). \tag{3.2.2}$$

Note that "a temperature of so many degrees on the Fahrenheit scale" is written ^{o}F and "a temperature of so many degrees on the Celsius scale" is written ^{o}C; whereas "a temperature *interval* of so many Fahrenheit degrees" is written F^{o} and "a temperature interval of so many Celsius degrees" is written C^{o}. In either case, the degrees symbol (^{o}) is mandatory.

In scientific work, we generally use the Kelvin temperature scale. The two fixed points on the Kelvin scale are the absolute zero of temperature, which is assigned the temperature 0 K, and the triple point of the water-ice-steam system, which is assigned the temperature 273.16 K. Thus it could reasonably be said that the Kelvin scale is not a centigrade scale, since it doesn't have 100 degrees between its two fixed points. However, the size of the degree on the Kelvin scale is almost exactly the same as the size of the Celsius degree, because the absolute zero of temperature is about –273.15 ^{o}C and the temperature of the triple point is about 0.01 ^{o}C. The definition of the Kelvin scale, however, does not mention the Celsius scale, and therefore, although the size of the degrees is about the same on both scales, this is not inherent in the definition. One might speculate about what might happen in the far distant future if people no longer use the Celsius scale and it is totally forgotten. People then will wonder what possessed us to divide the Kelvin scale into 273.16 divisions between its two fixed points!

It would not be good enough to define the upper fixed point of the kelvin scale as the temperature of "melting ice", because this depends on the pressure. The triple point is the temperature at which ice, water and steam are in equilibrium, and it occurs at a temperature of about 0.01 ^{o}C and exactly 273.16 K, and a pressure of about 610.6 Pa.

The Kelvin scale starts at zero at the lowest conceivable temperature. The kelvin (K) is therefore regarded as a *unit of temperature*, much as a metre is regarded as a unit of length, or a kilogram as a unit of mass. One therefore does not talk about a temperature of so many "degrees Kelvin", any more than one would talk about a length of so many "degrees metre" or a mass of so many "degrees kilogram". When using the Kelvin scale, therefore, we talk simply of a temperature of "280 kelvins" or "280 K". We do not use the word "degree", nor do we use the symbol ^{o}.

In the British Engineering System of units, which is used exclusively in the United States and has never been used in Britain, the Rankine scale is used. The lower fixed point is the absolute zero of temperature, and it is assigned the temperature 0 R, and the size of the rankine is equal to the size of the Fahrenheit degree. Melting ice at 0 ^{o}C has a temperature of 459.67 R, and the triple point has a temperature of 459.688 R.

I doubt whether the Réaumur scale has been used anywhere in the last 50 years, but it has probably been used in the last 100. This had melting ice at 0 o R and steam at 80 ^{o}R. I mention this only to point out that if you see a temperature given as so many ^{o}R, you might not know whether the Rankine or Réaumur scale is intended! (Strictly, °R would denote degrees Réaumur, while R would denote rankines – but can you trust that?)

In these notes, the Kelvin scale will be the scale that is normally used. There may be occasional use of the Celsius scale, but we shall not use the Fahrenheit, Rankine or Réaumur scales.