

100 Years Third Law of Thermodynamics: Revisiting the Consequences for Temperature

A. Laesecke^{S,C}

*Physical and Chemical Properties Division, National Institute of Standards and Technology, Boulder, CO,
U.S.A.*

Arno.Laesecke@Boulder.NIST.Gov

Near the end of Albert Einstein's miraculous year 1905, the German physical chemist Walther Nernst (1864-1941) presented on December 23 at a meeting of the Königlische Gesellschaft der Wissenschaften zu Göttingen (Royal Academy of Sciences) his heat theorem [1], which became known as the Third Law of Thermodynamics. While the law implies the unattainability of absolute zero, no changes of temperature scales were made to incorporate this new insight. Thus, absolute zero is still represented as a "point" rather than as a singularity and as a result its unattainability is often overlooked. The realization of Bose-Einstein condensation at nanokelvin temperatures and the continuing advance of low-temperature physics to picokelvins creates a growing need to correct the inconsistency in the representation of absolute zero. A natural choice is the inverse absolute temperature, which could be called the Nernst-temperature to distinguish it from the Kelvin-temperature. The appropriateness of the Nernst-temperature will be shown in a number of examples ranging from statistical mechanics to the representation of negative temperatures. An interesting aspect is that the Nernst-temperature increases in opposite direction to the physiological sensation of hot and cold. Did Celsius know about this when he assigned 100 degrees to the melting point of water ice and zero degrees to the boiling point of water?

- [1] W. Nernst, *Über die Berechnung chemischer Gleichgewichte aus thermischen Messungen*. Nachrichten von der Königlischen Gesellschaft der Wissenschaften zu Göttingen, 1-40 (1906).