Question #78225

The Sackur–Tetrode equation is an expression for the entropy of a monatomic classical ideal gas which incorporates quantum considerations which give a more detailed description of its regime of validity. The Sackur–Tetrode equation is this:

$$\frac{S}{kN} = \ln\left[\frac{V}{N}\left(\frac{4\pi m}{3h^2}\cdot\frac{U}{N}\right)^{3/2}\right] + \frac{5}{2}$$

where V is the volume of the gas, N is the number of particles in the gas, U is the internal energy of the gas, k is Boltzmann's constant, m is the mass of a gas particle, h is Planck's constant, and ln is the natural logarithm.

In statistical mechanics, a semi-classical derivation of the entropy that does not take into account the indistinguishability of particles, yields an expression for the entropy which is not extensive (is not proportional to the amount of substance in question). This leads to a paradox known as the Gibbs paradox. The paradox allows for the entropy of closed systems to decrease, violating the second law of thermodynamics. A related paradox is the "mixing paradox". If one takes the perspective that the definition of entropy must be changed so as to ignore particle permutation, the paradox is averted.

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