List of Equations

$$U = \frac{f}{2} n R T$$

$$= \frac{f}{2} N k T$$

Internal energy is equal to half the number of degrees of freedom times the product of the number of moles, the gas constant R, and the temperature/times the product of the number of molecules, Boltzmann's constant k, and the temperature.

R = 8.31 J/K*mole;   k = 1.38e-23 J/K

$$PV = nRT = NkT$$

The ideal gas equation. The product of the pressure and the volume is equal to the product of the number of moles, gas constant R, and the temperature, and the product of the number of molecules, the Boltzmann constant k, and the temperature.

Can be used to find the work done by an ideal gas process.

$$S = k \ln (\Omega)$$

Entropy equals the product of the Boltzmann constant k and the natural log of the multiplicity of a given macrostate, i.e. the number of microstates in a given macrostate.

This shows us that the entropy is dependent on the number of possible configurations a system can arrange itself into.

$$\Delta S = \frac{\Delta Q}{T}$$

The change in entropy equals the change in heat over the temperature.

This comes from the second law of thermodynamics.

Can be used for a reversible process.

$$T = \left(\frac{\partial S}{\partial U} \right)_{V,N}^{-1}$$

The temperature is inversely related to the change of the entropy with respect to the internal energy, assuming the both the number of molecules and volume of a system stay constant.

Comes from the definition of temperature

$$\left(\frac{\partial S}{\partial V} \right)_{U,N} = \frac{P}{T}$$

The change of the entropy with respect to the volume is related to the ratio of the pressure and the temperature.

Fundamental thermodynamic relationship)Comes from the first law of thermodynamics.)

$$\left(\frac{\partial S}{\partial N}\right)_{V,U} = -\frac{\mu}{T}$$

The change of the entropy with respect to the number of molecules is related to the negative ratio of the chemical potential and the temperature.

$$\partial W = \left(\frac{\partial W}{\partial P}\right)_V \partial P + \left(\frac{\partial W}{\partial V}\right)_P \partial V$$

The exact differential of work considering the change of work with respect to a change in volume and pressure.

Gives us the total work done by a system.

Because this is a exact differential, we can say that the work will be path independent.

$$\left[\frac{\partial}{\partial V}\left(\frac{\partial W}{\partial P}\right)_V\right]_P = \left[\frac{\partial}{\partial P}\left(\frac{\partial W}{\partial V}\right)_P\right]_V$$

Another way of that stating the exact differential of work given above. For a given first order partial derivative with respect to either the volume or pressure, the second order partial derivatives of with respect to the other variable will equal each other, following from the symmetry of second order partial derivatives.

i.e. For a given function of two variables, the second order partial derivative of both variables has an interchangeable order.

The Sackur-Tetrode equation for the entropy of an ideal monoatomic ideal gas.

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