Equilibrium and State Quantities

$pV = NkT$ Ideal gas law (GNS. 1.2)

$pV = mN\frac{1}{3}\left\langle \mathrm{v}^2 \right\rangle = \frac{2}{3}N\left\langle \epsilon_{\mathrm{kin}} \right\rangle$ Kinetic theory of ideal gas (GNS. 1.10)

$\delta W = -p\, dV$ Infinitesimal work done by a change in volume (GNS. 1.20)

$\delta W = \mu\, dN$ Infinitesimal work done by adding a particle against potential μ (GNS. 1.24)

$\delta Q = C\, dT$ Infinitesimal heat added against heat capacity C (GNS. 1.25)

$\left[p + \left(\frac{N}{V}\right)^2 a\right](V - Nb) = NkT$ Van de Waals' equation (GNS. 1.33)

The Laws of Thermodynamics

$dU = \delta W + \delta Q$ First law of thermodynamics (GNS. 2.1)

$U = \frac{3}{2}NkT$ Internal energy of an ideal gas (GNS. 2.2)

$C_V = \frac{3}{2}Nk$ Specific heat at constant volume of ideal gas (GNS. 2.2 & 2.4)

$\left(\frac{T}{T_0}\right)^{3/2} = \frac{V_0}{V}, \quad \left(\frac{T}{T_0}\right)^{5/2} = \frac{p}{p_0}, \quad \frac{p}{p_0} = \left(\frac{V_0}{V}\right)^{5/3}$

Adiabatic equations of the ideal gas (GNS 2.6 & 2.7)

$\oint \frac{\delta Q_{\mathrm{rev}}}{T} = 0$ Conservation of reduced heat for reversible cyclic processes (GNS. 2.26)

$dS = \frac{\delta Q_{\mathrm{rev}}}{T}$ Definition of entropy (GNS. 2.28)

$\delta Q_{\mathrm{irr}} < \delta Q_{\mathrm{rev}} = T\, dS$ Infinitesimal change in heat in terms of entropy (GNS 2.33)

$dS = 0, \quad S = S_{\mathrm{max}}$ Entropy of isolated system in equilibrium (GNS 2.34)

$dS \geq 0$ Second law of thermodynamics (GNS 2.35)

$dU = T\, dS - p\, dV + \mu\, dN + \phi\, dq$ First law for reversible processes (GNS 2.36)