Force: $\mathbf{F} = \frac{d\mathbf{p}}{dt}$
Angular Momentum: $\mathbf{L} = \mathbf{r} \times \mathbf{p}$
Torque: $\mathbf{N} = \frac{d\mathbf{L}}{dt} = \mathbf{r} \times \mathbf{F}$
Work (Energy): $W = \int \mathbf{F} \cdot d\mathbf{l}$
Potential Energy: $\mathbf{F} = -\nabla U$
Total Energy: $E = T + U$
Pressure: $p = F/A$
Power: $P = \frac{dE}{dt} = \mathbf{F} \cdot \mathbf{v}$
Electric Field: $\mathbf{F} = q\mathbf{E}$
Current: $\mathbf{J} = \rho \mathbf{v}$
Electric Potential: $V = -\int \mathbf{E} \cdot d\mathbf{l}$
Magnetic Flux: $\Phi_B = \int_S \mathbf{B} \cdot d\mathbf{a}$
Inductance: $\Phi_B = LI$
Resistance: $V = IR$
Capacitance: $Q = CV$
Conductivity/Resistivity: $\mathbf{J} = \sigma \mathbf{E} = \frac{1}{\rho}\mathbf{E}$
Poynting Vector: $\mathbf{S} = \frac{1}{\mu_0}(\mathbf{E} \times \mathbf{B})$
Vector Potential: $\mathbf{B} = \nabla \times \mathbf{A}$
Electric Auxiliary Field: $\mathbf{D} = \epsilon_0 \mathbf{E} + \mathbf{P}$
Magnetic Auxiliary Field: $\mathbf{H} = \frac{1}{\mu_0}\mathbf{B} - \mathbf{M}$
Impedance: $Z = \frac{V}{I} = R + iX$
Phase Velocity: $v_p = \frac{\omega}{k}$
Group Velocity: $v_g = \frac{d\omega}{dk}$

Hooke's Law: $\mathbf{F} = -k\mathbf{x}$
Coulomb's Law: $\mathbf{F} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}\hat{\mathbf{r}}$
Biot-Savart Law: $\mathbf{B} = \frac{\mu_0 I}{4\pi}\int \frac{d\mathbf{l}' \times \hat{\mathbf{r}}}{r^2}$
Lorentz Force Law: $\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$
Gauss' Law: $\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0}$
Faraday's Law: $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$
Magnetic Gauss' Law: $\nabla \cdot \mathbf{B} = 0$
Maxwell-Ampere Law: $\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\partial \mathbf{E}}{\partial t}$
Continuity Equation: $\nabla \cdot \mathbf{J} + \frac{\partial \rho}{\partial t} = 0$

Perpendicular Electric B.C.: $\epsilon_1 E_1^{\perp} - \epsilon_2 E_2^{\perp} = \sigma_f$
Parallel Electric B.C.: $\mathbf{E}_1^{\parallel} - \mathbf{E}_2^{\parallel} = 0$
Perpendicular Magnetic B.C.: $B_1^{\perp} - B_2^{\perp} = 0$
Parallel Magnetic B.C.: $\frac{1}{\mu_1}\mathbf{B}_1^{\parallel} - \frac{1}{\mu_2}\mathbf{B}_2^{\parallel} = \mathbf{K}_f \times \hat{\mathbf{n}}$

Potential Energy of Point Charge: $U = qV$
Dipole Moment: $\mathbf{p} = \int \mathbf{x}' \rho(\mathbf{x}')\, d^3x' \to q\mathbf{d}$
Magnetic Moment: $\mathbf{m} = \frac{1}{2}\int \mathbf{x}' \times \mathbf{J}(\mathbf{x}')\, d^3x' \to I\mathbf{a}$
Linear Medium D Field: $\mathbf{D} = \epsilon \mathbf{E}$
Linear Medium H Field: $\mathbf{H} = \frac{1}{\mu}\mathbf{B}$
Polarization: $\mathbf{P} = \epsilon_o \chi_e \mathbf{E}$
Magnetization: $\mathbf{M} = \chi_m \mathbf{H}$
Electrostatic Pressure: $p = \sigma E_{avg}$
Electric Dipole Potential: $V_{dip} = \frac{1}{4\pi\epsilon_0}\frac{\mathbf{p} \cdot \hat{\mathbf{r}}}{r^2}$
Electric Dipole Energy: $U = -\mathbf{p} \cdot \mathbf{E}$
Magnetic Dipole Energy: $U = -\mathbf{m} \cdot \mathbf{B}$

Torque on Electric Dipole: $\mathbf{N} = \mathbf{p} \times \mathbf{E}$
Torque on Magnetic Dipole: $\mathbf{N} = \mathbf{m} \times \mathbf{B}$
Electromotive Force: $\varepsilon = -\frac{d\Phi_B}{dt}$
Bound Charge: $\rho_b = -\nabla \cdot \mathbf{P} \quad \sigma_b = \mathbf{P} \cdot \hat{\mathbf{n}}$
Bound Current: $\mathbf{J}_b = \nabla \times \mathbf{M} \quad \mathbf{K}_b = \mathbf{M} \times \hat{\mathbf{n}}$
Gradient of Potential: $\nabla\left(\frac{1}{r}\right) = \frac{\hat{\mathbf{r}}}{r^2}$
Divergence of Electric Field: $\nabla \cdot \left(\frac{\hat{\mathbf{r}}}{r^2}\right) = 4\pi\delta^3(\mathbf{r})$
Spherical Method of Images: $x' = \left(\frac{a}{x}\right)a \quad q' = -\left(\frac{a}{x}\right)q$
Electric Field: $\mathbf{E} = -\nabla V - \frac{\partial \mathbf{A}}{\partial t}$
Field Energy: $U = \frac{1}{2}\int\left(\epsilon_0 E^2 + \frac{1}{\mu_0}B^2\right)\, d^3x$
Electric Field Outside a Conductor: $\mathbf{E} = \frac{\sigma}{\epsilon_0}\hat{\mathbf{n}}$
Magnetic Field of a Solenoid: $\mathbf{B} = \mu_0 n I \hat{\mathbf{z}}$
Magnetic Field of a Wire: $\mathbf{B} = \frac{\mu_0 I}{2\pi r}\hat{\phi}$
Resistance: $R = \rho L/A$
Circuit Impedance: $Z_L = i\omega L \quad Z_C = \frac{1}{i\omega C}$
Impedance of a Medium: $Z = \sqrt{\frac{\mu}{\epsilon}}$
Poisson's Equation: $\nabla^2 V = -\frac{\rho}{\epsilon_0} \quad \nabla^2 \mathbf{A} = -\mu_0 \mathbf{J}$
Electric Potential: $V(\mathbf{x}) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\mathbf{x}')}{|\mathbf{x}-\mathbf{x}'|}\, d^3x'$
Vector Potential: $\mathbf{A}(\mathbf{x}) = \frac{\mu_0}{4\pi}\int \frac{\mathbf{J}(\mathbf{x}')}{|\mathbf{x}-\mathbf{x}'|}\, d^3x'$

Snell's Law: $n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$
Plasma Dispersion Relation: $k^2 c^2 \cong \omega^2 - \omega_p^2$
Plasma Susceptibility: $\frac{\epsilon(\omega)}{\epsilon_0} \cong 1 - \frac{\omega_p^2}{\omega^2}$
Plasma Frequency: $\omega_p^2 = \frac{ne^2}{\epsilon_0 m}$
Skin Depth: $\delta = \sqrt{\frac{2}{\mu\sigma\omega}}$
Speed of light in medium: $v = c/n = 1/\sqrt{\mu\epsilon}$
Fields of a plane wave: $E = cB$
Larmor Formula: $P = \frac{\mu_0}{6\pi c}q^2 a^2$
Complex Poynting Vector: $\tilde{\mathbf{S}} = \tilde{\mathbf{E}} \times \tilde{\mathbf{H}}^*$
Power per solid angle: $\left\langle \frac{dP}{d\Omega} \right\rangle = \frac{1}{2}\mathrm{Re}[r^2 \hat{\mathbf{n}} \cdot \tilde{\mathbf{E}} \times \tilde{\mathbf{H}}^*]$

Relativistic Energy: $E^2 = p^2 c^2 + m^2 c^4$
Relativistic Energy for Massive Particle: $E = \gamma m c^2$
Relativistic Momentum: $\mathbf{p} = \gamma m \mathbf{u}$
Relativity Notation: $\gamma = 1/\sqrt{1-\beta^2} \quad \beta = \mathbf{v}/c$
Field Trans. (cgs): $\mathbf{E}' = \gamma(\mathbf{E} + \beta \times \mathbf{B}) - \frac{\gamma^2}{\gamma+1}\beta(\beta \cdot \mathbf{E})$
Field Trans. (cgs): $\mathbf{B}' = \gamma(\mathbf{B} - \beta \times \mathbf{E}) - \frac{\gamma^2}{\gamma+1}\beta(\beta \cdot \mathbf{B})$

Green's Functions: $\nabla^2 G(\mathbf{x}, \mathbf{x}') = \delta^3(\mathbf{x} - \mathbf{x}')$
Fundamental Solution: $G(\mathbf{x}, \mathbf{x}') = -\frac{1}{4\pi}\frac{1}{|\mathbf{x}-\mathbf{x}'|}$
Azimuthal: $V(r,\theta) = \sum_{l=0}^{\infty}\left(A_l r^l + \frac{B_l}{r^{l+1}}\right)P_l(\cos(\theta))$
Divergence Theorem: $\int_V \nabla \cdot \mathbf{A}\, d^3x = \oint_S \mathbf{A} \cdot d\mathbf{a}$
Stokes' Theorem: $\int_S (\nabla \times \mathbf{A}) \cdot d\mathbf{a} = \oint_C \mathbf{A} \cdot d\mathbf{l}$
Spherical Gradient: $\nabla = \frac{\partial}{\partial r}\hat{\mathbf{r}} + \frac{1}{r}\frac{\partial}{\partial \theta}\hat{\theta} + \frac{1}{r\sin(\theta)}\frac{\partial}{\partial \phi}\hat{\phi}$
Cylindrical Gradient: $\nabla = \frac{\partial}{\partial r}\hat{\mathbf{r}} + \frac{1}{r}\frac{\partial}{\partial \phi}\hat{\phi} + \frac{\partial}{\partial z}\hat{\mathbf{z}}$
Cylindrical Laplacian: $\nabla^2 = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2}{\partial \phi^2} + \frac{\partial^2}{\partial z^2}$

Spherical Laplacian: $\nabla^2 = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right) + \frac{1}{r^2\sin(\theta)}\frac{\partial}{\partial \theta}\left(\sin(\theta)\frac{\partial}{\partial \theta}\right) + \frac{1}{r^2\sin^2(\theta)}\frac{\partial^2}{\partial \phi^2}$

Green's Functions Potential: $V(\mathbf{x}) = -4\pi\int_V G(\mathbf{x}, \mathbf{x}')\rho(\mathbf{x}')\, d^3x' + \oint_S \left(V(\mathbf{x}')\frac{\partial G(\mathbf{x}, \mathbf{x}')}{\partial n'} - G(\mathbf{x}, \mathbf{x}')\frac{\partial V(\mathbf{x}')}{\partial n'}\right) da'$

Spherical Harmonic Expansion: $\frac{1}{|\mathbf{x}-\mathbf{x}'|} = \sum_{l=0}^{\infty}\frac{r_<^l}{r_>^{l+1}}P_l(\cos(\gamma)) = 4\pi\sum_{l=0}^{\infty}\sum_{m=-l}^{l}\frac{1}{2l+1}\frac{r_<^l}{r_>^{l+1}}Y_{lm}^*(\theta', \phi')Y_{lm}(\theta, \phi)$

Multipole Expansion: $V(\mathbf{x}) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\mathbf{x}')}{|\mathbf{x}-\mathbf{x}'|}\, d^3x' = \frac{1}{\epsilon_0}\sum_{l=0}^{\infty}\sum_{m=-l}^{l}\frac{1}{2l+1}\left[\int Y_{lm}^*(\theta', \phi')r'^l\rho(\mathbf{x}')\, d^3x'\right]\frac{Y_{lm}(\theta, \phi)}{r^{l+1}}$

BAC-BAC (Back to Back) Vector Identity: $\mathbf{A} \times (\mathbf{B} \times \mathbf{C}) = \mathbf{B}(\mathbf{A} \cdot \mathbf{C}) - (\mathbf{B} \cdot \mathbf{A})\mathbf{C}$

Fundamentals

Probability Postulate: $P(\lambda) = |\langle \lambda | \psi \rangle|^2$

Shrodinger's Equation: $-\frac{\hbar^2}{2m}\nabla^2\psi + V\psi = i\hbar\frac{\partial}{\partial t}\psi$

Momentum Operator: $\mathbf{p} = -i\hbar\nabla$

de Broglie Relation: $p = \frac{h}{\lambda} = \hbar k$

Expectation Value: $\langle A \rangle = \langle \psi | A | \psi \rangle$

Definition of Unitary: $U^\dagger = U^{-1}$

Stationary States: $|\psi(t)\rangle = e^{-iHt/\hbar}|\psi(0)\rangle$

Canonical Commutation Relation: $[x_i, p_j] = i\hbar\delta_{ij}$

Jacobi Identity: $[A, BC] = B[A, C] - [B, A]C$

Identity Operator: $I = \sum_i |\phi_i\rangle\langle\phi_i|$

Hermitian Conjugate: $\langle\psi_1|A^\dagger|\psi_2\rangle = \langle\psi_2|A|\psi_1\rangle^*$

Definition of Hermitian: $A^\dagger = A$

Hermitian Conjugate of Product: $(AB)^\dagger = B^\dagger A^\dagger$

Uncertainty Principle: $\sigma_A^2\sigma_B^2 \geq -\frac{1}{4}\langle\psi|[A, B]|\psi\rangle^2$

Variational Method: $\langle\psi|H|\psi\rangle \geq E_0 \quad \forall\,|\psi\rangle$

Expectation Evolution: $\frac{d\langle Q\rangle}{dt} = \frac{i}{\hbar}\langle[H, Q]\rangle + \left\langle\frac{\partial Q}{\partial t}\right\rangle$

Generalized Coordinates: $p \equiv \frac{\partial L}{\partial \dot{q}} \quad \dot{p} = -\frac{\partial H}{\partial q} \quad \dot{q} = \frac{\partial H}{\partial p}$

Mathematics

Variance: $\sigma_x^2 \equiv \langle(x - \langle x\rangle)^2\rangle = \langle x^2\rangle - \langle x\rangle^2$

Euler's Equation: $e^{ix} = \cos(x) + i\sin(x)$

Gamma Integral: $\int_0^\infty x^n e^{-x}\,dx = \Gamma(n+1)$

Gaussian Integral: $\int_0^\infty x^n e^{-x^2}\,dx = \frac{1}{2}\Gamma(\frac{n+1}{2})$

Gamma Properties: $\Gamma(n+1) = n\Gamma(n), \quad \Gamma(\frac{1}{2}) = \sqrt{\pi}$

Exponential Approximation: $e^x \cong 1 + x \quad (x \ll 1)$

Square Root Approximation: $\sqrt{1+x} \cong 1 + \frac{x}{2} \quad (x \ll 1)$

Simple Harmonic Oscillator

Lowering Operator: $a = \frac{1}{\sqrt{2m\omega\hbar}}(m\omega x + ip)$

Hamiltonian: $H_{SHO} = \frac{p^2}{2m} + \frac{1}{2}m\omega^2x^2 = (a^\dagger a + \frac{1}{2})\hbar\omega$

Energy Levels: $E_n = (n + \frac{1}{2})\hbar\omega$

Position Dimensions: $x_o = \sqrt{\frac{\hbar}{2m\omega}}$

Momentum Dimensions: $x_o p_o = \hbar/2$

Position Operator: $x = x_o(a^\dagger + a)$

Momentum Operator: $p = ip_o(a^\dagger - a)$

Ladder Operators: $[a, a^\dagger] = 1$

Raising: $a^\dagger|\psi_n\rangle = \sqrt{n+1}|\psi_{n+1}\rangle$

Lowering: $a|\psi_n\rangle = \sqrt{n}|\psi_n\rangle$

Number Operator: $N|\psi_n\rangle = a^\dagger a|\psi_n\rangle = n|\psi_n\rangle$

Ground State: $a|\psi_0\rangle = 0$

Angular Momentum

L_z Operator: $L_z = -i\hbar\frac{\partial}{\partial z}$

Definition of $\mathbf{J}$: $\mathbf{J} = \mathbf{L} + \mathbf{s}$

J_z Eigenvalue: $J_z|j\ m\rangle = \hbar m|j\ m\rangle$

J^2 Eigenvalue: $\mathbf{J}^2|j\ m\rangle = \hbar^2 j(j+1)|j\ m\rangle$

Angular Momentum Operators: $(\bar{J}_i)_{jk} = -i\epsilon_{ijk}$

Commutator: $[\bar{J}_i, \bar{J}_j] = i\sum_k \epsilon_{ijk}\bar{J}_k$

Ladder Operators: $J_\pm = J_x \pm iJ_y$

Ladder: $J_\pm|j, m\rangle = \hbar\sqrt{j(j+1) - m(m\pm 1)}|j, m\pm 1\rangle$

Spin and Magnetism

Pauli Matrices: $\sigma_x = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \quad \sigma_y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad \sigma_z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

Spin Singlet: $|0, 0\rangle = \frac{1}{\sqrt{2}}(|+-\rangle - |-+\rangle)$

Spin Triplet $(m = 0)$: $|1, 0\rangle = \frac{1}{\sqrt{2}}(|+-\rangle + |-+\rangle)$

Spin Triplet $(m \neq 0)$: $|1, 1\rangle = |++\rangle \quad |1, -1\rangle = |--\rangle$

Magnetism: $H_{mag} = -\mu \cdot B = \mu_B(L \cdot B + \sigma \cdot B)$

Electron Magnetic Moment: $\mu = -\mu_B L$

Bohr Magneton: $\mu_B = \frac{e\hbar}{2m}$

Spin Half Polarization: $\frac{dP}{dt} = H \times P$

Spin-Orbit Hamiltonian: $H_{LS} = \frac{\alpha}{2m^2}\frac{1}{r^3}L \cdot s$

Atoms

Fine Structure Constant: $ke^2 = \alpha\hbar c$

Bohr Radius: $a = \frac{\hbar}{mc\alpha}$

Reduced Mass: $\mu = \frac{m_1 m_2}{m_1 + m_2}$

Hydrogen-like Atom Hamiltonian: $H = \frac{p^2}{2\mu} - \frac{Ze^2}{r}$

Hydrogen Energies: $E_n = -\frac{mk^2Z^2e^4}{2\hbar^2n^2} = -\frac{Z^2\alpha^2}{2n^2}mc^2$

Virial Theorem: $2\langle\psi|T|\psi\rangle = \langle\psi|r\frac{\partial V}{\partial r}|\psi\rangle$

Coulomb Virial Theorem: $\langle E\rangle = -\langle T\rangle$

Hydrogen Ground State: $\psi_1(r, \theta, \phi) = \frac{a^{-3/2}}{\sqrt{\pi}}e^{-r/a}$

Scattering

Wavefunction: $\psi(r) = \frac{1}{(2\pi)^{3/2}}\left[e^{ik\cdot r} + f(\theta, \phi)\frac{e^{ikr}}{r}\right]$

Cross Section: $\sigma_{tot} = \int \frac{d\sigma}{d\Omega}d\Omega = \int |f(\theta, \phi)|^2 d\Omega$

Amp.: $f = \frac{-(2\pi)^{3/2}}{4\pi}\frac{2m}{\hbar^2}\int e^{-i\mathbf{k}'\cdot\mathbf{x}'}V(\mathbf{x}')\psi(\mathbf{x}')d^3x'$

Born: $f^{(1)}(\mathbf{k}', \mathbf{k}) = -\frac{1}{4\pi}\frac{2m}{\hbar^2}\int V(\mathbf{x}')e^{i(\mathbf{k}-\mathbf{k}')\cdot\mathbf{x}'}\,d^3x'$

Sym. Born: $f^{(1)}(\theta, \phi) = -\frac{2m}{\hbar^2}\frac{1}{q}\int_0^\infty rV(r)\sin(qr)\,dr$

Momentum Transfer: $q \equiv |\mathbf{k} - \mathbf{k}'| = 2k\sin(\theta_{sc}/2)$

Optical Theorem: $\sigma_{tot} = \frac{4\pi}{k}\mathrm{Im}(f(0))$

Selection Rules: $\langle\alpha' j' m'|T_q^k|\alpha j m\rangle = 0$ unless $m' = m + q$ and $|j - k| \leq j' \leq j + k$

Perturbation Theory: $\Delta_n = E_n - E_n^0 = \langle\psi_n^0|H'|\psi_n^0\rangle - \sum_{m\neq n}\frac{|\langle\psi_m^0|H'|\psi_n^0\rangle|^2}{E_m^0 - E_n^0} + ...$

Time-Dependent Perturbation Theory: $\langle\psi_f|\psi(t)\rangle \cong \delta_{fi} - \frac{i}{\hbar}\int_0^t \langle\phi_f|H^1(t')|\phi_i\rangle e^{i\omega_{fi}t'}\,dt'$

WKB Approximation for Semi-Infinite Potential: $\int_0^{x_2}\sqrt{2m(E_n - V(x))}\,dx = (n - \frac{1}{4})\pi\hbar \quad (n \in \mathbb{Z}^+)$

Baker-Hausdorff Lemma: $e^{iB}Ae^{-iB} = A + i[B, A] - \frac{1}{2}[B, [B, A]] + ... + \frac{i^n}{n!}[B, [B, [B..., [B, A]]]] + ...$

Fundamentals

Fundamental Relation:	$dE = TdS - pdV + \mu dN$
Heat Definition:	$Q \equiv \Delta E + W$
Entropy Definition:	$S \equiv k\ln(\Omega)$
Beta Definition:	$\beta \equiv \frac{\partial \Omega}{\partial E}$
Temperature Definition:	$T \equiv \frac{1}{k\beta}$
Boltzmann Factor:	$P(\epsilon) \propto e^{-\beta\epsilon}$
Ideal Gas Law:	$pV = NkT$
Ideal Gas Energy:	$E = \frac{3}{2}NkT$
Pressure:	$p = -\left(\frac{\partial E}{\partial V}\right)_S$
Heat Capacity Definition:	$C_y \equiv \left(\frac{dQ}{dT}\right)_y$
Heat Capacity (Volume):	$C_V = \left(\frac{\partial E}{\partial T}\right)_V = T\left(\frac{\partial S}{\partial T}\right)_V$
Chemical Potential:	$\mu \equiv -T\left(\frac{\partial S}{\partial N}\right)_{EVM} = \left(\frac{\partial E}{\partial N}\right)_{SVN}$
Magnetic Susceptibility Definition:	$M_0 = \chi H$
Magnetization:	$\bar{M}_0 = N_0\bar{\mu}_H = \sum_r \mu_{H_r} n_r$
Magnetization Relation:	$M_0 = M/V$
Magnetic Moment:	$\mu = g\mu_B \mathbf{s}/\hbar$
Efficiency:	$\eta = \frac{T_1 - T_2}{T_1}$
Equipartition Theorem:	$\bar{\epsilon}_i = \frac{1}{2}kT$
Sterling Approximation:	$\ln(N!) \cong N\ln(N) - N$

Partition Functions

Partition Function:	$Z \equiv \sum_j e^{-\beta E_j}$
N Particles:	$Z = \frac{z^N}{N!}$
Helmholtz Free Energy:	$F = -kT\ln(Z)$
Energy:	$E = -\frac{\partial \ln(Z)}{\partial \beta}$
Pressure:	$p = \frac{1}{\beta}\frac{\partial \ln(Z)}{\partial V}$
Entropy:	$S = k\left(\ln(Z) + \beta E\right)$
Heat Capacity:	$C_V = k\beta^2 \frac{\partial^2 \ln(Z)}{\partial \beta^2}$
Alpha:	$\alpha = \frac{\partial \ln(Z)}{\partial N}$
Chemical Potential:	$\mu_j = -kT\frac{\partial \ln(Z)}{\partial N_j}$
Mean Particles Per State:	$\bar{n}_s = -\frac{1}{\beta}\frac{\partial \ln(Z)}{\partial \epsilon_s}$
Mean Square Fluctuation:	$\overline{n_s^2} = \frac{1}{\beta^2 Z}\frac{\partial^2 Z}{\partial \epsilon_s^2}$
Dispersion:	$\overline{(\Delta n_s)^2} = \frac{1}{\beta^2}\frac{\partial^2 \ln(Z)}{\partial \epsilon_s^2}$

Legendre Transformations

Energy:	$E(S,V,N) \equiv E$
Enthalpy:	$H(S,p,N) \equiv E + pV$
Helmholtz Free Energy:	$F(T,V,N) \equiv E - TS$
Gibbs Free Energy:	$G(T,p,N) \equiv E - TS + pV$

Kinetic Theory

Maxwell Distribution:	$f(\mathbf{v}) = n\left(\frac{m}{2\pi kT}\right)^{\frac{3}{2}} e^{-mv^2/2kT}$
Component Dist.:	$g(v_x) = n\left(\frac{m}{2\pi kT}\right)^{\frac{1}{2}} e^{-mv_x^2/2kT}$
Mean Lifetime:	$\tau = \frac{1}{n\bar{v}\sigma}$
Mean Velocity:	$\bar{v} = \sqrt{\frac{8}{\pi}\frac{kT}{m}}$
RMS Velocity:	$v_{rms} = \sqrt{3\frac{kT}{m}}$
Most Probable Velocity:	$\tilde{v} = \sqrt{2\frac{kT}{m}}$

Quantum Statistics

Alpha:	$\alpha = -\beta\mu$
Grand Canonical P.F.:	$Z_G = \sum_{N'} Z(N')e^{-\alpha N'}$
Photon Gas Pressure:	$p = \frac{E}{3V}$
Total Particles:	$N = \int_0^\infty f(\epsilon)\rho(\epsilon)\, d\epsilon$
Total Energy:	$E = \int_0^\infty \epsilon f(\epsilon)\rho(\epsilon)\, d\epsilon$
FD Distribution Function:	$f(\epsilon_s) = \bar{n}_s = \frac{1}{e^{\beta(\epsilon_s - \mu)} + 1}$
BE Distribution Function:	$f(\epsilon_s) = \bar{n}_s = \frac{1}{e^{\beta(\epsilon_s - \mu)} - 1}$
BEC Integral:	$\int_0^\infty \frac{x^n}{e^x - 1}\, dx = \Gamma(n+1)\zeta(n+1)$