PHY 7500, Equations, Fall 2008

$$\sigma = \ln\Omega; \quad S = k\sigma; \quad \left(\frac{\partial\sigma}{\partial E}\right)_{N,V} \equiv \frac{1}{T} = \beta; \qquad (1)$$

$$\left(\frac{\partial\sigma}{\partial V}\right)_N \equiv \frac{P}{T}; \quad \left(\frac{\partial\sigma}{\partial N}\right)_V \equiv -\frac{\mu}{T} \qquad (2)$$

$$dE = Td\sigma - PdV + \mu dN \qquad (3)$$

$$C_V = T\left(\frac{\partial\sigma}{\partial T}\right)_V; \quad C_P = T\left(\frac{\partial\sigma}{\partial T}\right)_P;$$
$$\kappa_T = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T \qquad (4)$$

$$A(T,V) = E - T\sigma; \quad G(T,P) = A + PV = \mu N \qquad (5)$$

$$Q_N = \sum_i e^{-E_i/T}; \quad A = -T\ln Q_N; \quad E = \frac{\partial(A/T)}{\partial(1/T)} \qquad (6)$$

$$M = -\left(\frac{\partial A}{\partial B}\right)_T; \quad \chi = \frac{1}{V}\left(\frac{\partial M}{\partial B}\right)_{B=0}; \ \mu_e = \frac{1}{2}\frac{e\hbar}{mc} \qquad (7)$$

$$Z = \sum_N z^N Q_N; \quad z = e^{\mu/T}; \quad \Phi_G = -T\ln Z = -PV \qquad (8)$$

$$\langle(\Delta E)^2\rangle = -\frac{\partial\langle E\rangle}{\partial\beta}; \ \langle(\Delta N)^2\rangle = T\frac{\partial\langle N\rangle}{\partial\mu} \qquad (9)$$

$$(n+2)K = nE + 3PV \qquad (10)$$

$$\bar{n}_B = \frac{1}{e^{(\varepsilon-\mu)/T} - 1}; \quad \bar{n}_F = \frac{1}{e^{(\varepsilon-\mu)/T} + 1} \qquad (11)$$

$$N = \frac{V}{\lambda^3}\, g_{3/2}(z); \quad PV = \frac{TV}{\lambda^3}\, g_{5/3}(z) = \frac{2}{3}E \qquad (12)$$

$$dE_\omega = \frac{V\hbar}{\pi^2 c^3}\frac{\omega^3 d\omega}{e^{hw/T} - 1}; \quad I = \sigma T^4 \qquad (13)$$

$$\lambda = \hbar\left(\frac{2\pi}{mT}\right)^{1/2}; \quad \int \frac{dp}{2\pi\hbar} e^{-p^2/2mT} = \frac{1}{\lambda} \qquad (14)$$

$$Pv = T\sum_{l=1}^{\infty} a_l(\lambda^3/v)^{l-1}; \quad v = 1/n = V/N \qquad (15)$$

$$\frac{P}{T} = \frac{1}{\lambda^3}\sum_{l=1}^{\infty} b_l z^l; \quad \frac{N}{V} = \frac{1}{\lambda^3}\sum_{l=1}^{\infty} l b_l z^l \qquad (16)$$

$$b_l = \frac{1}{l!\lambda^{3(l-1)}V}(\text{the sum of all l} - \text{clusters}) \qquad (17)$$

$$a_1 = b_1 = 1; \quad a_2 = -b_2; \quad a_3 = 4b_2 - 2b_3 = -2b_3^{irr} \qquad (18)$$

$$b_2 = \frac{1}{2\lambda^3 V}\int f_{12} d^3x_1 d^3x_2;$$
$$b_3^{irr} = \frac{1}{6\lambda^6 V}\int f_{12}f_{13}f_{32} d^3x_1 d^3x_2 d^3x_3;$$
$$f_{12} = (e^{-U(r_{12})/T} - 1) \qquad (19)$$

$$(P + \frac{a}{v^2})(v - b) = T \qquad (20)$$

$$C_V \sim \begin{cases} (T - T_c)^{-\alpha} & T > T_c \\ (T_c - T)^{-\alpha'} & T < T_c \end{cases} \qquad (21)$$

$$m \sim (T_c - T)^\beta \quad (h = 0, T \le T_c) \qquad (22)$$

$$\chi \sim \begin{cases} (T - T_c)^{-\gamma} & T > T_c \\ (T_c - T)^{-\gamma'} & T < T_c \end{cases} \qquad (23)$$

$$m \sim h^{1/\delta} \quad (T = T_c) \qquad (24)$$

$$g(i,j) = \langle\sigma_i\sigma_j\rangle - \langle\sigma_i\rangle\langle\sigma_j\rangle \qquad (25)$$

$$g(\mathbf{r}) = \frac{1}{(2\pi)^3}\int |\Delta\sigma(\mathbf{k})|^2 e^{i\mathbf{kr}} d^3k \qquad (26)$$

$$g(r) \sim \frac{e^{-r/\xi}}{r^{d-2+\eta}}; \quad \xi \sim 1/t^\nu \qquad (27)$$

$$d\nu = 2 - \alpha \qquad (28)$$

$$\text{div}(\mathbf{j}) + \frac{\partial n}{\partial t} = 0 \qquad (29)$$

$$n! \approx \sqrt{2\pi n}e^{-n}n^n \qquad (30)$$

$$\int_{-\infty}^{\infty} e^{-\alpha x^2} dx = \sqrt{\pi/\alpha} \qquad (31)$$

$$g_\nu(z) = \frac{1}{\Gamma(\nu)}\int_0^\infty \frac{x^{\nu-1}dx}{z^{-1}e^x - 1} = z + \frac{z^2}{2^\nu} + \frac{z^3}{3^\nu} + \ldots \qquad (32)$$

$$\int_0^\infty \frac{f(\varepsilon)d\varepsilon}{e^{(\varepsilon-\mu)/T} + 1} = \int_0^\mu f(\varepsilon)d\varepsilon + \frac{\pi^2}{6}(T)^2 f'(\mu)$$
$$+ \frac{7\pi^4}{360}(T)^4 f'''(\mu) + \ldots \qquad (33)$$