FYSA242, kevät 2016, koepaperiin tulee mukaan seuraava kaavakokoelma
FYSA242, spring 2016, the exam question sheet will include the following collection of formulas

$k_B = 1.3805 \times 10^{-23}\mathrm{J/K} \quad R = k_B N_A = 8.3143\mathrm{J/molK} \quad N_A = 6.022 \times 10^{23}/\mathrm{mol}$

$k_B \cdot 300\mathrm{K} \approx \frac{1}{40}\mathrm{eV} \quad 0°\mathrm{C} = 273.15\mathrm{K} \quad 1\mathrm{atm} = 101.3\mathrm{kPa} \quad g = 9.82\mathrm{m/s}^2 \quad c = 3.00 \cdot 10^8\mathrm{m/s}$

$\hbar = 1.05 \cdot 10^{-34}\mathrm{Js} = 6.58 \cdot 10^{-16}\mathrm{eVs} \quad m_e c^2 = 511\mathrm{keV} \quad 1\mathrm{u} = 1.66 \cdot 10^{-27}\mathrm{kg}$

$\mathrm{d}E = đQ + đW \overset{\text{rev.}}{=} T\mathrm{d}S - P\mathrm{d}V \quad \mathrm{d}E = T\mathrm{d}S - P\mathrm{d}V + \mu \mathrm{d}N$

$F = E - TS \quad G = E - TS + PV \quad H = E + PV \quad \Omega_G = E - TS - \mu N = -PV$

$S = k_B \ln \Omega \quad \ln n! \approx n \ln n - n \quad \begin{pmatrix} N \\ n \end{pmatrix} \equiv \frac{N!}{n!(N-n)!}$

$F = -k_B T \ln Z \quad E = -\frac{\partial}{\partial \beta} \ln Z$

$C_V \equiv T \left(\frac{\mathrm{d}S}{\mathrm{d}T}\right)_{V,N} = \left(\frac{\mathrm{d}E}{\mathrm{d}T}\right)_{V,N} \quad C_P \equiv T \left(\frac{\mathrm{d}S}{\mathrm{d}T}\right)_{P,N} \quad \kappa_T \equiv -\frac{1}{V}\left(\frac{\mathrm{d}V}{\mathrm{d}P}\right)_{T,N} \quad \kappa_S \equiv -\frac{1}{V}\left(\frac{\mathrm{d}V}{\mathrm{d}P}\right)_{S,N}$

$\left(\frac{\partial x}{\partial y}\right)_z = \left[\left(\frac{\partial y}{\partial x}\right)_z\right]^{-1} \quad \left(\frac{\partial x}{\partial y}\right)_z = \left(\frac{\partial x}{\partial w}\right)_z \left(\frac{\partial w}{\partial y}\right)_z \quad \left(\frac{\partial x}{\partial y}\right)_z \left(\frac{\partial y}{\partial z}\right)_x \left(\frac{\partial z}{\partial x}\right)_y = -1$

$S = -k_B \sum_\nu p_\nu \ln p_\nu \quad p_\nu = \frac{1}{Z} e^{-\beta E_\nu} \quad Z = \sum_\nu e^{-\beta E_\nu} \quad \beta \equiv 1/(k_B T)$

$p_\nu = \frac{1}{\mathcal{Z}} e^{-\beta(E_\nu - N_\nu)} \quad \mathcal{Z} = \sum_\nu e^{-\beta(E_\nu - \mu N_\nu)} \quad \Omega_G(T, V, \mu) = -k_B T \ln \mathcal{Z}$

$\lambda_D = \sqrt{\frac{2\pi\hbar^2}{m k_B T}} \quad Z_1(T, V) = V \left(\frac{m k_B T}{2\pi\hbar^2}\right)^{3/2} \quad Z_N = \frac{1}{N!}\left[Z_1(T, V)\right]^N,$

$PV = N k_B T = nRT \quad E = \frac{3}{2} N k_B T \quad \left(\frac{\mathrm{d}P}{\mathrm{d}T}\right)_{\mathrm{cx}} = \frac{\Delta S}{\Delta V} = \frac{L_{1\to 2}(T)}{T \Delta V}$

$n_{FD}(\varepsilon) = \frac{1}{e^{\beta(\varepsilon_{\mathbf{k}} - \mu)} + 1} \quad n_{BE}(\varepsilon) = \frac{1}{e^{\beta(\varepsilon_{\mathbf{k}} - \mu)} - 1} \quad \int_0^\infty \frac{x^n \mathrm{d}x}{e^x - 1} = n!\zeta(n+1)$

$\Omega_G^{FD} = -k_B T \sum_r \ln\left[1 + e^{-\beta(\varepsilon_r - \mu)}\right] \quad \Omega_G^{BE} = +k_B T \sum_r \ln\left[1 - e^{-\beta(\varepsilon_r - \mu)}\right]$

$f(k)\mathrm{d}k = \frac{gV}{2\pi^2} k^2 \mathrm{d}k \quad \varepsilon(k) = \frac{\hbar^2 k^2}{2m} \quad \varepsilon(k) = \hbar c k$

$\zeta(s) = \sum_{n=1}^\infty \frac{1}{n^s} \qquad \zeta(3/2) \approx 2.61 \quad \zeta(2) = \frac{\pi^2}{6} \approx 1.64 \quad \zeta(5/2) \approx 1.34$

$\zeta(3) \approx 1.20 \quad \zeta(7/2) \approx 1.13 \quad \zeta(4) = \frac{\pi^4}{90} \approx 1.08$

$\int_0^\infty \mathrm{d}\varepsilon \frac{f(\varepsilon)}{e^{\beta(\varepsilon - \mu)} + 1} \approx \int_0^\mu \mathrm{d}\varepsilon f(\varepsilon) + \frac{\pi^2}{6}(k_B T)^2 \left.\frac{\mathrm{d}f(\varepsilon)}{\mathrm{d}\varepsilon}\right|_\mu + \mathcal{O}(T^4)$

$\sinh x \equiv \frac{1}{2}\left(e^x - e^{-x}\right) \quad \cosh x \equiv \frac{1}{2}\left(e^x + e^{-x}\right) \quad \tanh x \equiv \frac{\sinh x}{\cosh x}$

$\sum_{n=0}^\infty x^n = \frac{1}{1-x}, |x| < 1 \quad \sum_{n=1}^\infty \frac{1}{n} x^n = -\ln(1-x), |x| < 1$

$e^x = \sum_{n=0}^\infty \frac{x^n}{n!} \quad (a+b)^N = \sum_{n=0}^N \begin{pmatrix} N \\ n \end{pmatrix} a^n b^{N-n}$