SIGNATURE ____________________  NAME ______________________

Student ID # ____________________

**Physics 404**
**Spring 2011**
**Prof. Anlage**
**FINAL Exam**
**17 May, 2011**
**CLOSED BOOK, NO Calculator Permitted, CRIB SHEET ALLOWED**
**Point totals are given for each part of the question.**

If you run out of room, continue writing on the back of the same page. If you do so, make a note on the front part of the page!

Note: You must solve the problem following the instructions given in the problem. Correct answers alone will not receive full credit.

**Partial Credit:**

→ Show Your Work! Answers written with no explanation will not receive full credit.

→ You can receive credit for describing the method you would use to solve a problem, even if you missed an earlier part.

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| Problem | Credit | Max. Credit |
|---|---|---|
| 1 | | 25 |
| 2 | | 25 |
| 3 | | 25 |
| 4 | | 25 |
| TOTAL | | 100 |

$\int_{-\infty}^{+\infty} \exp(-x^2)dx = \pi^{1/2}$  $\int_{-\infty}^{+\infty} x^2\exp(-x^2)dx = \frac{\pi^{1/2}}{2}$  $n! \cong (2\pi n)^{1/2} n^n \exp\left[-n + \frac{1}{12n}\right]$  $\frac{1}{1-x} = \sum_{n=0}^{\infty} x^n$

$F = -\tau \log(Z) = U - \tau\sigma$; $dU(\sigma, V) = \tau d\sigma - PdV + \mu dN$; $dF(\tau, V, N) = -\sigma d\tau - PdV + \mu dN$

$Z = \sum_s Exp[-\varepsilon_s/\tau]$  $\frac{1}{\tau} = \partial\sigma/\partial U|_{V,N}$  $C_V = \frac{\partial U}{\partial \tau}|_V$  $\langle N\rangle = \sum_s f(\varepsilon_s)$

$d(XY) = X\,dY + Y\,dX$  $\log(AB) = \log(A) + \log(B)$  $\log(A+B) \neq \log(A) + \log(B)$

$g(N,s) = \frac{N!}{\left(\frac{N}{2}+s\right)!\left(\frac{N}{2}-s\right)!} \cong \sqrt{\frac{2}{\pi N}}\, 2^N e^{-2s^2/N}$  $g(s) = \sum_s g_1(s_1) g_2(s - s_1)$  $P(\varepsilon_s) = \mathrm{Exp}\left(-\frac{\varepsilon_s}{\tau}\right)/Z$

$\langle X\rangle = \sum_s X(s)P(s)$  $p = -\left(\frac{\partial U}{\partial V}\right)|_\sigma = \tau\left(\frac{\partial \sigma}{\partial V}\right)|_U = -\left(\frac{\partial F}{\partial V}\right)|_\tau$  $Z_N = \left(n_Q V\right)^N/N!$

$n_Q = (M\tau/2\pi\hbar^2)^{3/2}$  $pV = N\tau$  $U = \frac{3}{2}N\tau$  $\sigma = N\left[log\left(\frac{n_Q}{n}\right) + \frac{5}{2}\right]$

$Z_{classical,\,d=1} = \frac{1}{h}\iint e^{\left(\frac{-H(p,q)}{\tau}\right)} dpdq$  $\mathbf{Z} = \sum_N e^{\left(\frac{N\mu}{\tau}\right)} \sum_s e^{\left(\frac{-\varepsilon_s(N)}{\tau}\right)}$  $\int \log(x)dx = x\log(x) - x$  $\frac{dp}{d\tau} = \frac{L}{\tau\,\Delta v}$

$\left(P + \frac{N^2 a}{V^2}\right)(V - Nb) = N\tau$  $G_g - G_l = \int V\,dP$  $m = \tanh(m/t)$