



Date

2010 秋 統計

$$(1) \quad \epsilon(p) = c|p| \quad \left. \begin{array}{l} c(p) \\ \end{array} \right\}$$

$$Z_1 = \frac{\iiint e^{-\frac{c}{kT}|p|} dp_x dp_y dp_z}{\iiint e^{-\frac{c}{kT}|p|} dp_x dp_y dp_z}$$

$$= \frac{\int_0^\infty c p^3 e^{-\frac{c}{kT}p} dp}{\int_0^\infty p^2 e^{-\frac{c}{kT}p} dp}$$

$$= \frac{c \int_0^\infty 3p^2 e^{-\frac{c}{kT}p} \cdot \frac{kT}{c} dp}{\int_0^\infty p^2 e^{-\frac{c}{kT}p} dp} = 3c \cdot \frac{kT}{c} = \underline{3kT}$$

$$Z = \frac{1}{N!} Z_1^N = \frac{1}{N!} (3kT)^N$$

$$(2) \quad F = -kT \log Z_N$$

$$= -NkT \log 3kT + kT \log N!$$

$$= kT (-N \log 3kT + N \log N - N)$$

$$= NkT \left( \log \frac{N}{3kT} - 1 \right)$$

$$(3) \quad P = - \frac{\partial F}{\partial V}$$

$$dF = dU - SdT - TdS$$

$$dU = d'Q - PdV$$

$$dS = \frac{d'Q}{T}$$

$$dF = TdS - PdV - SdT - TdS$$

$$= -PdV - SdT$$