

$$f(T, v) = -\frac{1}{\beta} \lim_{\substack{N, v \rightarrow \infty \\ \frac{v}{N} = v}} \left[1 + \ln \left(\frac{2\pi m}{\beta h^2} \right) + \ln v \right]$$

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$$df = -s dT - p dv$$

$$-p = \frac{\partial f}{\partial v}, \quad -s = \frac{\partial f}{\partial T}$$