

Kittel TP.

$$3.3. (a). \quad Z = \sum_{s=0}^{\infty} \exp\left[-\frac{\hbar\omega}{\gamma} s\right]$$
$$= \frac{1}{1 - \exp\left[-\frac{\hbar\omega}{\gamma}\right]}$$

$$F = -\gamma \ln Z = -\gamma \ln \left[\frac{1}{1 - \exp\left[-\frac{\hbar\omega}{\gamma}\right]} \right]$$
$$= \gamma \ln \left[1 - \exp\left[-\frac{\hbar\omega}{\gamma}\right] \right]$$

$$(b). \quad \sigma = -\left(\frac{\partial F}{\partial \gamma}\right)_V = -\ln \left[1 - \exp\left[-\frac{\hbar\omega}{\gamma}\right] \right]$$
$$- \gamma \left[1 - \exp\left[-\frac{\hbar\omega}{\gamma}\right] \right]^{-1} \left[-\left(\frac{\hbar\omega}{\gamma^2}\right) \exp\left[-\frac{\hbar\omega}{\gamma}\right] \right]$$

$$= -\frac{\hbar\omega/\gamma}{1 - \exp\left[-\frac{\hbar\omega}{\gamma}\right]} - \ln \left[1 - \exp\left[-\frac{\hbar\omega}{\gamma}\right] \right]$$