Kittel TP

5.6 (a). $\mathcal{Z} = \sum_{ASN} \exp[(N\mu - \varepsilon_s(N))/\tau]$

$$= \sum_{s} \exp[(N\mu - \varepsilon_s(N))/\tau] \Big|_{N=0}$$

$$+ \sum_{s} \exp[(N\mu - \varepsilon_s(N))/\tau] \Big|_{N=1}.$$

$$= \boxed{1 + \lambda + \lambda \exp[-\varepsilon/\tau]}$$

(b) $\Rightarrow$ $\langle N \rangle = \dfrac{0(1) + 1(\lambda) + 1(\lambda \exp[-\varepsilon/\tau])}{\mathcal{Z}}.$

(c): $\langle N(\varepsilon) \rangle = \dfrac{0(1) + 0(\lambda) + 1(\lambda \exp[-\varepsilon/\tau])}{\mathcal{Z}}.$

(d). $\langle \varepsilon \rangle = \dfrac{0(1) + 0(\lambda + \varepsilon(\lambda \exp[-\varepsilon/\tau])}{\mathcal{Z}}.$

(e). This modification is equivalent to taking the sum in part (a) to go to $N=2$, giving an additional term of

$$\exp[(2\mu - \varepsilon)/\tau] = \lambda^2 \exp[-\varepsilon/\tau].$$

$\Rightarrow$ $\mathcal{Z} = 1 + \lambda + \lambda \exp[-\varepsilon/\tau] + \lambda^2 \exp[-\varepsilon/\tau]$

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