(c) (96) ⇒

and again I have an extra factor of 2.

$$\Rightarrow f = -\tau\left(\frac{\partial \sigma}{\partial \ell}\right)_u = -\tau\left(\frac{-2\ell}{N\rho^2}\right) = \frac{2\ell\tau}{N\rho^2}$$

(3.) Kittel 4.2 - Surface temperature of the Sun

(a) Power $P = \frac{\text{power}}{\text{unit area}} \cdot \text{area} = 0.136\,\mathrm{J\,s^{-1}\,cm^{-2}} \cdot 4\pi\,(15\times10^{13}\,\mathrm{cm})^2 =$

$$= 3.8\times10^{26}\,\frac{\mathrm{J}}{\mathrm{s}} \approx 4\times10^{26}\,\frac{\mathrm{J}}{\mathrm{s}}$$

(b) $J_u = \sigma_B T^4$, where

J_u = flux density of radiant energy = $\frac{\text{energy}}{\text{unit area} \times \text{unit time}}$

The energy is coming from the surface of the Sun, so

$$J_u = \frac{P}{\text{area}} = \frac{4\times10^{26}\,\frac{\mathrm{J}}{\mathrm{s}}}{4\pi(7\times10^{10}\,\mathrm{cm})^2} = 6496\,\frac{\mathrm{J}}{\mathrm{s\,cm^2}}$$

Then

$$T = \left(\frac{J_u}{\sigma_B}\right)^{1/4} = \left(\frac{6496\ \mathrm{J/s\,cm^2}}{5.67\times10^{-12}\,\frac{\mathrm{J}}{\mathrm{s\,cm^2\,K^4}}}\right)^{1/4} = 5818\,\mathrm{K} \approx 6000\,\mathrm{K}$$

(4.) Kittel 4.6

(a) Start with $U = \sum_j s_j \hbar \omega_j$, from eq. (7) or (16), where we set $\langle s\rangle = s_j$

Now I'll show that $\left(\frac{\partial s_j}{\partial V}\right)_\sigma = 0$. From (23) $\sigma = \text{const}\, V\tau^3$. From (15), $\omega_n \propto \frac{1}{L} = \frac{1}{V^{1/3}} = \frac{\tau}{(V\tau^3)^{1/3}} \propto \frac{\tau}{\sigma^{1/3}}$, so if $\sigma = \text{const}$ then $\omega_n \propto \tau$ and $\omega_n/\tau = \text{const}$.

From (6) we see that that implies that $s_j = \text{const}$, so $\left(\frac{\partial s_j}{\partial V}\right)_\sigma = 0$.

Hence,

$$p = -\left(\frac{\partial U}{\partial V}\right)_\sigma = -\sum_j \frac{\partial}{\partial V}(s_j\hbar\omega_j)_\sigma = -\sum_j s_j\hbar\left(\frac{\partial \omega_j}{\partial V}\right)$$