a) $\rho_0 = \frac{(2s+1)}{(2\pi\hbar)^2}\left[\int dp\, e^{-p^2/2mT}\right]^2 = \frac{mT}{\hbar^2 \pi}$

b) $\rho = \frac{(2s+1)}{(2\pi\hbar)^2}\int d^2p \left\{ e^{-p^2/2mT + \beta\mu} - e^{-2p^2/2mT + 2\beta\mu} \right\}$

$= \rho_0 \left(e^{\beta\mu} - \frac{1}{2} e^{2\beta\mu} \right)$ where we used $\frac{x}{1+x} \approx x - x^2$ on $f(p)$

c) To second order,

$\rho^2 \approx \rho_0^2 e^{2\beta\mu}$ (cross terms are higher order)

d) $P = \frac{T(2s+1)}{(2\pi\hbar)^2}\int d^2p \ln\left\{ 1 + e^{-\beta\left(\frac{p^2}{2m} - \mu\right)} \right\}$

$\approx \frac{T(2)}{(2\pi\hbar)^2}\int d^2p \left(e^{-\beta\left(\frac{p^2}{2m} - \mu\right)} - \frac{1}{2} e^{-2\beta\left(\frac{p^2}{2m} - \mu\right)} \right)$

since $\ln(1+x) \approx x - \frac{1}{2}x^2 + \ldots$

$= T\rho_0 e^{\beta\mu} - \frac{1}{4} T \frac{\rho_0^2}{\rho_0} e^{2\beta\mu}$

$\longrightarrow \delta P = \frac{1}{4} T e^{2\beta\mu} \frac{\rho_0^2}{\rho_0} = \frac{1}{4} T \frac{\rho^2}{\rho_0}$

e) From δP, it can be seen that

A_2 is $\frac{1}{4}$