FD gas in $D$ dimensions: chemical potential II

Start from the results derived in [tex117] to infer the following expressions for the fugacity $z$ and the chemical potential $\mu$ at $T \ll T_F$:

$$\ln z \sim \frac{T_F}{T}, \quad \frac{\mu}{k_B T_F} = 1 - \frac{\pi^2}{12} (D - 2) \left( \frac{T}{T_F} \right)^2 + O(T^3).$$

Solution: