1. A drop of poison is placed into the middle of a long narrow pipe carrying water. The poison then diffuses away from the initial position, $x = 0$, toward $x = \pm\infty$. The diffusion equation is
$$\frac{\partial \rho}{\partial t} = D \frac{\partial^2 \rho}{\partial x^2},$$
where ρ is the number of poison molecules per unit length. If the net number of molecules is N, find an expression for $\rho(x,t)$ in terms of N and D.

2. Consider a non-accelerating Hubble expansion, where freezeout occurs for both photons and the mythical spartino at a temperature of $T_0 = 3 \times 10^5$ K, when the age of the universe is $\tau_0 = 1.4 \times 10^5$ years. The phase space density of the photons at this time is thermal with temperature T_0. The spartino is an extremely massive fermionic particle, whose phase space density at freeze-out was also thermal and was given by:
$$f_{\rm spartino}(p, \tau_0) = \frac{\exp\left(\mu_0/T_0 - p^2/2mT_0\right)}{1 + \exp\left(\mu_0/T_0 - p^2/2mT_0\right)}.$$
Later, at a time τ, the spartino's phase distribution is
$$f_{\rm spartino}(p, \tau) = \frac{\exp\left(\mu/T - p^2/2mT\right)}{1 + \exp\left(\mu/T - p^2/2mT\right)}.$$
For time $\tau = 1.4 \times 10^{10}$ years, find
   (a) The temperature describing the spectrum of photons.
   (b) The temperature T describing the spartino spectrum above
   (c) In terms of μ_0, what is the new chemical potential μ?