J00T.3—Bose-Einstein Condensation by Evaporation

Problem

The object of this problem is to find a method for producing Bose-Einstein condensation by means of evaporation. Consider a thermally insulating container of volume V containing N noninteracting particles obeying Bose-Einstein statistics.

a) Find the equilibrium particle distribution in momentum space in terms of the temperature and chemical potential when the particle number density is less than the critical value $\rho_c(T)$ for Bose-Einstein condensation.

b) Find the equilibrium particle distribution in momentum space when the particle number density is larger than $\rho_c(T)$.

c) The critical density $\rho_c(T)$ for Bose-Einstein condensation scales with temperature as T^γ. Use this distribution (plus some elementary scaling) to find γ.

d) Suppose, at first, that the density ρ is at the critical density $\rho_c(T)$. We allow some of the particles to escape. The few particles that escape have mean energy Ae, where e is the mean energy of the particles that remain and A is some experimentally determined constant. You are allowed to assume that the change in ρ is small. The system, which is thermally insulated, is then allowed to return to equilibrium. The question to be answered is this: For what values of A does the system remain in the condensed phase?