Phy 410
Quiz #10, April 17, 2009

(1) **Plot the Bose-Einstein distribution function $f_{BE}(\varepsilon)$ as a function of ε at a given τ when the chemical potential** $\mu = 0.$

$$f_{BE}(\varepsilon) = \frac{1}{e^{\frac{\varepsilon-\mu}{\tau}} - 1} = \frac{1}{e^{\frac{\varepsilon}{\tau}} - 1}; 0 < \varepsilon < \infty$$

This function diverges at $\varepsilon = 0$ and goes to zero as $e^{-\frac{\varepsilon}{\varsigma}}$ as $\varepsilon \to \infty$.

(2) **The Einstein condensation temperature *T_E* for bosons of mass *M* and density *N/V* is given by**

$$T_E = C\frac{(N/V)^{2/3}}{k_B M}$$

Where C is a constant.

For Rb atoms at density 10^{13} /cm^3 *T_E* is 10^{-7}K. If the density is increased to 10^{16}/cm^3, what will be *T_E*.

$$T_E \propto (N/V)^{2/3} \ for \ fixed \ M; T_E(10^{16}/cm^3) = T_E(10^{13}/cm^3)\left(\frac{10^{16}}{10^{13}}\right)^{2/3}$$

$$T_E(10^{16}/cm^3) = 10^{-7}K\left(10^3\right)^{2/3} = 10^{-7}K\left(10^2\right) = 10^{-5}K$$

What is *T_E* for hydrogen atom if the density is 10^{16}/cm^3.

(Use M_{Rb}=85 amu; M_H=1 amu)

$$T_E \propto \frac{1}{M} \ for \ a \ fixed \ density$$

$$T_E(H) = 85xT_E(RB) = 85x10^{-5}K$$