

PHYS 301
Thermodynamics and Statistical Mechanics

Homework Assignment 8

Due date: Monday April 6 2026 5pm, submitted on UNM Canvas

Question 1 (4 points).

One of the first experimental realizations of a Bose-Einstein condensate use rubidium-87 atoms cooled to extremely low temperatures. Imagine that we have 10^4 rubidium-87 atoms confined to a tiny volume $V = 10^{-15} \text{ m}^3$.

- (a) Compute the critical temperature T_c below which a Bose-Einstein condensate starts to form.
- (b) Suppose that $T = 0.9T_c$. How many atoms are in the ground state? How about at $T = 0.1T_c$?

Question 2 (4 points).

Assume that I have a non-relativistic bosonic gas in $d = 2$ spatial dimensions. Use the fact that the density of states is constant in this case to show that Bose-Einstein condensation does not occur no matter how low the temperature.

Question 3 (6 points).

Each atom in a chunk of copper contributes one conduction electron. Look up the density and atomic mass of copper, and calculate the Fermi energy, the Fermi temperature, and the degeneracy pressure. Is room temperature sufficiently low to treat this system as a degenerate electron gas?