ASSIGNMENT 10
(due W ednesday, April 2)

READING
Read Secs. 10.5 and 10.6, including the Special Topic on pp. 346–348. Also read Sec. 11.1.

PROBLEMS

Problem 1
5 points Problem 10.39

Problem 2
5 points Problem 10.45 (See Table 10.5)

Problem 3
5 points Problem 10.46

Problem 4
5 points Answer question 20 on page 357 in a few complete coherent sentences.

Problem 5
12 points Equation 9.66 of your book is the end point in a rough derivation of the temperature of the superfluid transition for liquid He. Use a similar argument to estimate the temperature at which rubidium gas, at a density of $10^{14} \text{cm}^{-3}$, becomes a Bose-Einstein condensate.

Problem 6
20 points The bulk compressibility $\kappa$ of a material is defined by

$$\kappa = -\frac{1}{\text{vol}} \left( \frac{\partial \text{vol}}{\partial p} \right)_{T} .$$

where vol is volume, and $p$ is pressure. At constant temperature, we can write the change in the total internal energy $U$ of a substance as $dU = -p \, d\text{vol}$, so that the compressibility becomes

$$\frac{1}{\kappa} = \text{vol} \frac{d^2 U}{d\text{vol}^2} .$$

Suppose that we are analyzing NaCl. Let $N$ denote the number of Na atoms in our sample, and let $U = NV(r)$ where $V(r)$ is the potential energy associated with each Na, as in Sec. 10.3. Note that

$$\text{vol} = 2Nr_0^3 ,$$

where $r_0$ is the distance from a Na lattice site to the nearest Cl neighbor. Use the above analysis, the form of the potential in Sec. 10.3, and the data in Table 10.2 to compute the bulk compressibility of NaCl. Look up the answer for this quantity and compare your computation. (There should be good agreement, on the order of 20% or better.)