04/30/02. **Due:** Tuesday, May 7, 2002 (in class).

Physics 540: Statistical Mechanics I

Read: LL 63, 66, 142, 143

"**LL** 1" means section 1 from Landau and Lifshitz book

Homework 12

Exercise 1

Using the Debye temperature of diamond $\theta_D \approx 2000K$, find its specific heat C at room temperature, and compare it to the classical limit.

Exercise 2

In a ferromagnetic solid at low temperatures quantized waves of magnetization (spin waves) have their frequency ω related to their wave vector according to $\omega = Ak^2$ where A is a constant. At low temperatures, find the temperature dependence of the heat capacity due to such spin waves.

Exercise 3

Electromagnetic radiation at temperature T_i fills a cavity of volume V. If the volume of the thermally insulated cavity is expanded quasistatically to a volume $8V$, what is the final temperature T_f? (Neglect the heat capacity of the cavity walls.) Solve this problem "from scratch", i.e., do not use any formulas except for obvious ones.

Exercise 4

An experimentalist found that at 99°C and 101°C the water pressure is 733.7 and 788.0 mm Hg respectively. Find the latent heat of evaporation of water from this data.

Exercise 5

Gibbs free energy for some system is given as a function of pressure, temperature, and two-component "order" parameter $\vec{\eta} = (\eta_x, \eta_y)$ by

$$G = G_0 + A\vec{\eta}^2 + B\left((\vec{\eta}^2)^2 + 2\epsilon\eta_x^2\eta_y^2\right).$$

Here $\vec{\eta}^2 = \eta_x^2 + \eta_y^2$, ϵ is some small positive number $0 < \epsilon < 1$, G_0, B are some smooth non-zero functions of P and T, and $A = a(T - T_c)$. T_c is the temperatue of phase transition.

a) Minimize G with respect to $\vec{\eta}$ near the phase transition ($\tau = (T - T_c)/T_c$ is as small as it is necessary).

b) What is the true order parameter for this phase transition.

c) Rewrite the Gibbs free energy near the phase transition as a function of the true order parameter only.

d) Find the discontinuity of the specific heat at the phase transition.