

PHY411 Homework Set 13

1. [5 pts] Kittel-Kroemer, problem 10-2.
2. [5 pts] Kittel-Kroemer, problem 10-3.
3. [10 pts] Consider the model of a ferromagnet developed in chapter 10 of the textbook and in the lecture.

- (a) Demonstrate that the energy per unit volume in this model, at sub-Curie temperatures, is

$$\frac{U}{V} = -\frac{\lambda M^2}{2}.$$

- (b) Determine the heat capacity C in this model, advancing the result as much as possible. Note that you will need to differentiate the relation arrived at in the class

$$\frac{MV}{Nm} = \tanh\left(\frac{m\lambda M}{\tau}\right),$$

yielding a parametric equation for $dM/d\tau$. Here m is the magnetic moment of a single atom. You may consider using reduced variables $\hat{\tau} = \tau/\tau_c$ and $\hat{M} = M/M_{\max}$.

- (c) Make a sketch of C vs τ , in parallel to the sketch for M .
4. [10 pts] Kittel-Kroemer, problem 10-8. You should presumably review the Debye theory and the Planck radiation law in Chapter 4 of the book. Pay particular attention to the way in which the entropy for the gas of photons is obtained. Note that in this problem different quantities are considered per unit volume. In (b) you need to show that the critical temperature is given by Eq. (84).