Homework Assignment #8
(due 12/14/16)

Reading:


Problems/Questions:

1. **Average Internal Flux Density in a Triangular Vortex Lattice.** In a mixed state of an isotropic type-II superconductor, the vortex lattice has triangular symmetry. Please show that the average internal flux internal flux density is

   \[ B = \frac{2\Phi_0}{3a^2} \]

   where \( a \) is the lattice constant.

2. Please discuss at least two different experimental methods for determining the critical temperature of a superconductor.

3. Why are metals shiny?

4. Silver, copper and gold have similar electronic configurations but we perceive them as having different colors. Why?

5. You have a sample in a box. You are allowed to ask two questions about its physical properties to determine if it is a metal, an insulator or a semiconductor. What do you choose to ask?

6. Consider a lead solenoid wound around a doughnut-shaped tube. The total number of turns is \( N \), and the diameter of the lead wire is \( d \). The solenoid is cooled below the critical point, at which an electric current is induced in the coil. Assuming the lead resistivity in the superconducting state to be less than \( 10^{25} \) ohm-m, please write an expression for the minimum time-interval needed for the current to damp out by 0.01% (where you may also assume that the length of wire is sufficiently large for the infinite-length approximation to hold). Please state if there are any other specific experimental parameters you would need besides those given (\( d, N \)) in order to determine this quantity.

7. Experiments show that even though a superconductor exhibits zero-static resistance, its ac resistance is finite, though very small. Explain how this is possible.

8. Please describe, drawing from your reading of the handout on Superconductivity by Norman, in a minimum of four sentences similarities and differences between the iron pnictide and the cuprate superconductors.
9. Please explain, drawing from your reading of the handout on Topological Insulators by Moore, what is a topological insulator and discuss it in comparison/contrast with graphene. Please also discuss possible applications. Please use a minimum of four sentences in your response.

10. Please summarize, drawing from your reading of the handout on two-dimensional crystals, why there is tremendous excitement in the physics community about this burgeoning area. Please be sure to include future directions in both research and applications, and use a minimum of four sentences in your response.