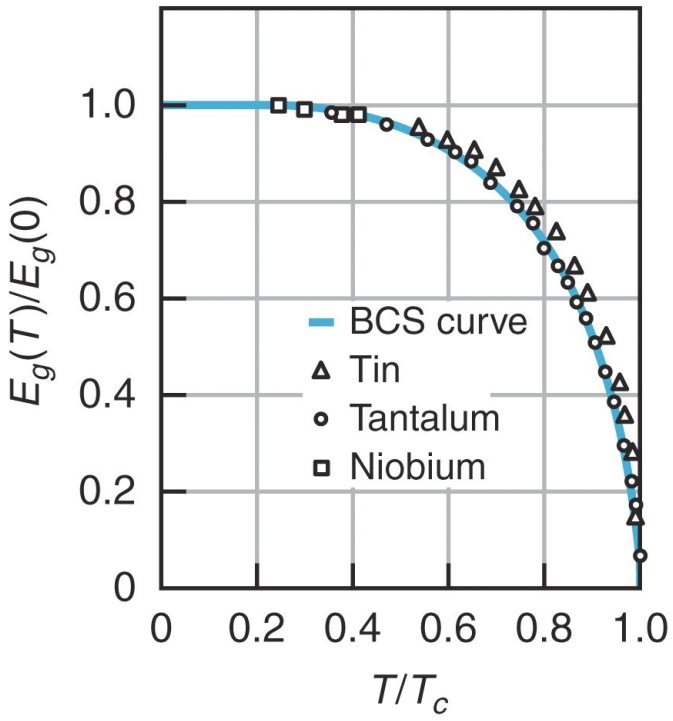
Physics 308: Assignment 9

Due in class Tuesday, April 8, 2008

1. (10-39) Three naturally occurring isotopes of lead are ^{206}Pb, ^{207}Pb, and ^{208}Pb. Using the value of α from Table 10-7 and the isotope masses from Appendix A, compute the critical temperatures of these isotopes.

2. (10-40) Compute (a) the superconducting energy gap for indium and (b) the wavelength of a photon just energetic enough to break up a Cooper pair in indium at $T = 0$.

3. (10-42) Using the BCS curve, shown in the figure below, estimate the energy gaps in (a) tin, (b) niobium, (c) aluminum, and (d) zinc, all at $T = 0.5T_c$. The material-specific values of T_c are given in Table 10-6. Express your answer in eV.



4. The London equation states that $\mathbf{j} = -(1/\mu_0\lambda_L^2)\mathbf{A}$, where $\mathbf{j}$ is the current, $\mathbf{A}$ is the vector potential of the magnetic field, and λ_L is the London penetration depth (having units of length). (a) Take the time derivative of the London equation to show that $\partial\mathbf{j}/\partial t = -(1/\mu_0\lambda_L^2)\mathbf{E}$. (b) If $md\mathbf{v}/dt = q\mathbf{E}$, as for free carriers of charge q and mass m, show that $\lambda_L = (\epsilon_0 mc^2/nq^2)^{1/2}$. (c) What are q and m for a Cooper pair (in relation to charge e and electron mass m_e)?