Physics 451- Fall 2012

Homework #24

Due Thursday, Dec 6, by 7pm

Please place your assignment in the "Physics 451" slot across from N373 ESC.
Help sessions T Th: from 3pm to 6pm – room 337 ESC

List of problems (from the textbook):

5.15
5.16
5.18
5.19
5.21

Hints:
For problem **5.16**: we need first to find the free electron density, by combining the Cu density of mass, the Cu atomic mass and the Avogadro number ($N_A = 6.02\times10^{23}$ = number of atoms in one mole)- check your dimensions. To calculate the Fermi energy, use eq. 5.43, the degeneracy pressure, use 5.46. Energy can be expressed in *Joules* or in *eV* ($1eV = 1.6\times10^{-19}\,J$), velocity might be expressed in m/s, temperature in *Kelvins* (K), and pressure in *Pascal* (1Pa = 1 N/m^2). Useful constants:
$\hbar = 1.05\times10^{-34}\,J.s$; $m_e = 9.11\times10^{-31}kg$; $N_A = 6.02\times10^{23}$; $k_B = 1.38\times10^{-23}\,J/K$

For problem **5.18**: for a) start from the general expression for $\psi(x)$ (eq.5.59), then use the continuity of ψ at boundary (eq 5.61) to express the amplitude B in terms of A and re-write ψ. Remember that *x* is the variable, and that *K*, *k*, and *a* are constants. For question b) use for example the top of the first band: calculate the value of *z*, *k* and *K* at that point, and calculate the amplitude *B*.

For pb **5.19:** once you have found the graphical solution for z, express the corresponding energy E in terms of *z*, β and the ratio α/a.

For pb **5.21:** the idea here is to find how many distinct values can be taken by $\cos(Ka)$.
Knowing that $K = \frac{2\pi}{Na}n$, there are *N* possibilities for integer *n* (from *0* to *N-1*, then *cos(Ka)* is recycling). But within one revolution 2π, some of the K values give the same result for *cos(Ka)*, so the energy level will be degenerate. Start with *N=1*, *N=2*, *N=3*, *N=4* etc… and count how many levels you get in each case, and their degeneracies.