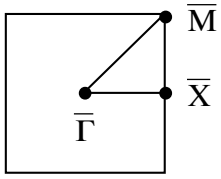
Name: _____

Advanced Solid State Physics — Prof. Dr. W. Kuch
Winter semester 2014/2015
5th exercise sheet

Submission: Tuesday, 18. November 2014, before the lecture
(or drop until 10 o'clock on the same day in mailbox between rooms 1.2.38 and 1.2.40)

13. Recapitulation of introductory solid state physics: Fermi energy (**) (4 points)
The energy up to which electronic states are occupied at T = 0 K is called the "Fermi energy". Cu has a Fermi energy of 8.5 eV. Calculate, under the assumption of free electrons, the number of (free) electrons per Cu atom, and compare your result with the electron configuration of a free Cu atom. Cu has an *fcc* lattice with lattice constant a = 3.61 Å.

14. Two-dimensional electronic band structure of free electrons (**) (4 points)
Sketch the energy dispersion of free electrons in a two-dimensional simple quadratic lattice with lattice constant (nearest-neighbor distance) a along the symmetry axes $\overline{\Gamma} \rightarrow \overline{X} \rightarrow \overline{M} \rightarrow \overline{\Gamma}$ (for the definition of these axes see the figure below).
Consider only energies between 0 and $\frac{7}{2}\frac{\hbar^2 G^2}{2m_e}$, where $G = \frac{2\pi}{a}$. Indicate the energy values of all bands at the symmetry points $\overline{\Gamma}$, $\overline{X}$, and $\overline{M}$ in units of $\frac{\hbar^2 G^2}{2m_e}$.
(Make sure to include all bands!)



Brillouin zone of the two-dimensional quadratic lattice

15. Band gaps (**) (4 points)
The elastic (angle-averaged) reflection of electrons at metal surfaces exhibits maxima at the energies of band gaps. Calculate the energy relative to the vacuum level of the first band gap above the vacuum level for electrons impinging perpendicularly on a Cu(111) surface. Assume nearly free electrons with an inner potential V_0 = 14 eV. Cu has an *fcc* lattice with lattice constant a = 3.61 Å.