HW # 3

1) Imagine an electron band described by the EK relation

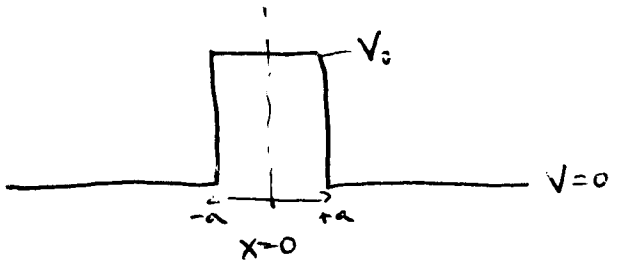
$$E(k) = C(1 - \cos ka)$$ for the Brillouin Zone defined by $-\frac{\pi}{a} < k < \frac{\pi}{a}$

a) For $k \approx 0$, use the parabolic approximation to find $m^*(k \sim 0)$

b) Use the definition of m^* to find the full expression for $m^*(k)$

c) If a constant force (F) is applied to an electron in this band, describe the ensuing motion of the electron.

2) Imagine a potential described below:



a) For $E < V_0$, determine the transmission through the barrier.

b) Plot T vs. V_0 and T vs. a

3] Imagine you have a finite 1D crystal defined by the Kronig-Penney model discussed in class. The crystal has N atoms.

a) What are the allowed K-vectors for electrons in this system, in the reduced / folded zone representation?

b) Ignoring spin, assume each atom has 4 loosely bound electrons, and electrons fill up the allowed K-states from low to high energy. How many bands are filled w/ electrons?

c) Including spin, how many bands are filled?

4| Using our derivation of a 1D crystal band structure, and assuming $a = b = 3\,\text{Å}$, V_0 or $U_0 = 1\,\text{eV}$

a) Plot $f(\zeta)$

b) Determine the width (in energy) of the first two energy bands and energy gaps.