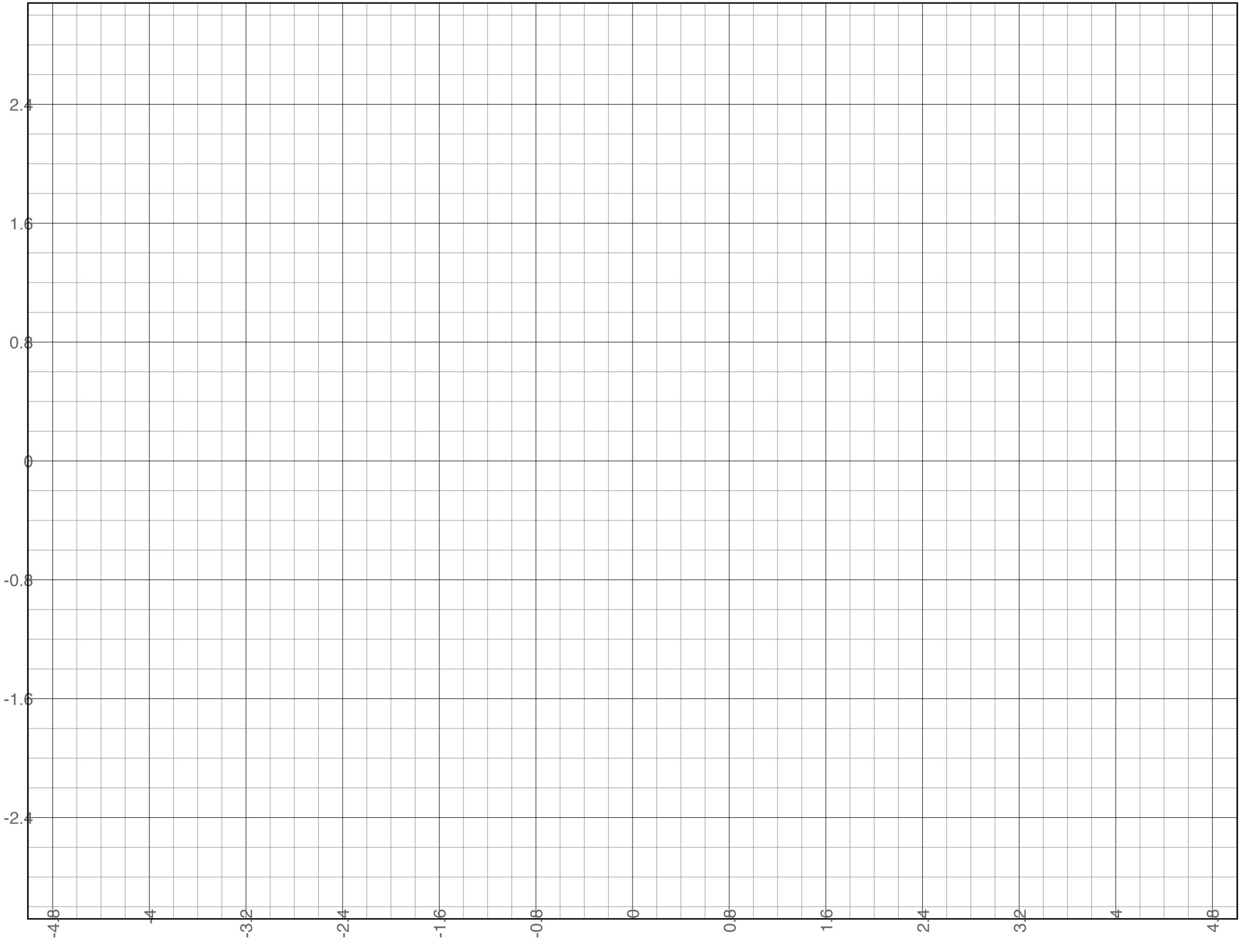
Homework #4 Jan 29, 2016

Problems (HH= Hook & Hall)

#1 HH 3.1 (Requires the use of QM tunneling result)
#2 HH 3.3
#3 HH 3.6
#4 Calculate the Fermi wave vector for a metal with electron density 10^{24} electrons per cubic cm. Calculate R the mean interparticle spacing between electrons at this density using cubic boxes to decompose the space. From this find an estimate of the Coulomb repulsion e^2/R between a pair of particles. Compare this with the energy of the Hydrogen atom.
{To solve this imagine each electron to be surrounded by a cube so that there is no double occupancy of the cubes. The cube side then provides an estimate of the mean separation between electrons. A more popular geometric construction is to put a sphere around each electron so the sphere touch but don't overlap. The diameter of the sphere is another estimate of the mean separation. What is the ratio of the two estimates?}

#5 Consider the two dimensional centered rectangular lattice with b smaller than a. Compute the packing fraction of this as a function of the angle θ between the diagonal and the x axis. Show that this is maximum at $\theta=\pi/6$. What is the geometric significance of this special angle?
{ To solve this problem draw a circle of radius b/2 around each corner and also the center of the rectangular. The packing fraction can be computed realizing that we have two circles inside the conventional unit cell and gives $PF= \pi/2 \, Tan(\theta)$. Draw a picture with various values of b/a (or equivalently θ) to find the significance of $\theta=\pi/6$- this can be fun...}

#6 Practice drawing lattice planes that cover the lattice on the attached graph paper, and write their Miller indices. Verify the relationship giving the distance between the planes and the Miller indices.


2.4
1.6
0.8
0
-0.8
-1.6
-2.4
-4.8
-4
-3.2
-2.4
-1.6
-0.8
0
0.8
1.6
2.4
3.2
4
4.8