EECS 277C Nanotechnology HW #1

Intro material: (particle in a box)

1. Consider a single electron in a box. Calculate the spacing between the lowest lying energy levels for a box of size a) 1 meter b) 1 micron c) 1 nanometer d) 1 Anstrom. How do these compare to kT at room temperature?
2. Calculate the density of states in a 2d world.

Tunneling:

1. Calculate the probability for an electron to tunnel through a 1 nm barrier that is 10 eV high. This is a good approximation for the tunnel junction shown in class. Use the formula below:



Now calculate the resistance of a tunnel junction based on the geometry of the device shown in class that was made by the professor.

Coulomb blockade:

1. A device shows Coulomb blockade at temperatures only well below 300 K. What is it’s size? (i.e. what is the capacitance of the tunnel barrier?)
2. Estimate the gate capacitance of a modern transistor. Assume a parallel plate capacitor with k=10, d= 10 nm, L=W=0.1 microns. Now, calculate how much energy it costs to add one electron to the gate (e2/C). Is this energy larger or smaller than a typical thermal energy (kBT)? At what technology node would you expect this to change?