**Semiconductor basics & P/N junction**

1.

1. Explain the concept of effective mass in a crystal lattice. (5 pts)
2. Assuming that light is absorbed by a homogeneous semiconductor material. Draw a plot of the absorption coefficient () vs. photon energy. (5 pts)
3. Explain the concept of carrier mobility. How is it related to the electric field? (5 pts)
4. Describe how the temperature affects charge carrier mobility in single-crystal silicon. (5 pts)

2. Conductivity () of an unknown piece of extrinsic semiconductor is measured as a function of temperature, as below.



1. Why does  increase at 0–100 K ? (5 pts)
2. Why does  decrease at 100–500 K ? (5 pts)
3. Why does  increase above 500 K ? (5 pts)

3. A P-N junction is formed in single-crystal silicon at room temperature (RT). Let’s assume that all dopants are activated (ionized).

*N*A: 6×1017 atoms/cm3 & *N*D: 1×1018 atoms/cm3  
Intrinsic carrier concentration of silicon at RT (n0): 1010 cm-3

1. Calculate the built-in potential (V). (5 pts)
2. In Maxwell’s equations, what is the formula that describes the relationship between electric charge and electric field? (5 pts)
3. Describe a simple relationship between electric field and electrostatic potential. (5 pts)
4. Qualitatively, plot the charge, electric field, and electrostatic potential profiles. Specify the depletion width in your answer, but you don’t have to calculate the width value. (10 pts)