Your Name:_____

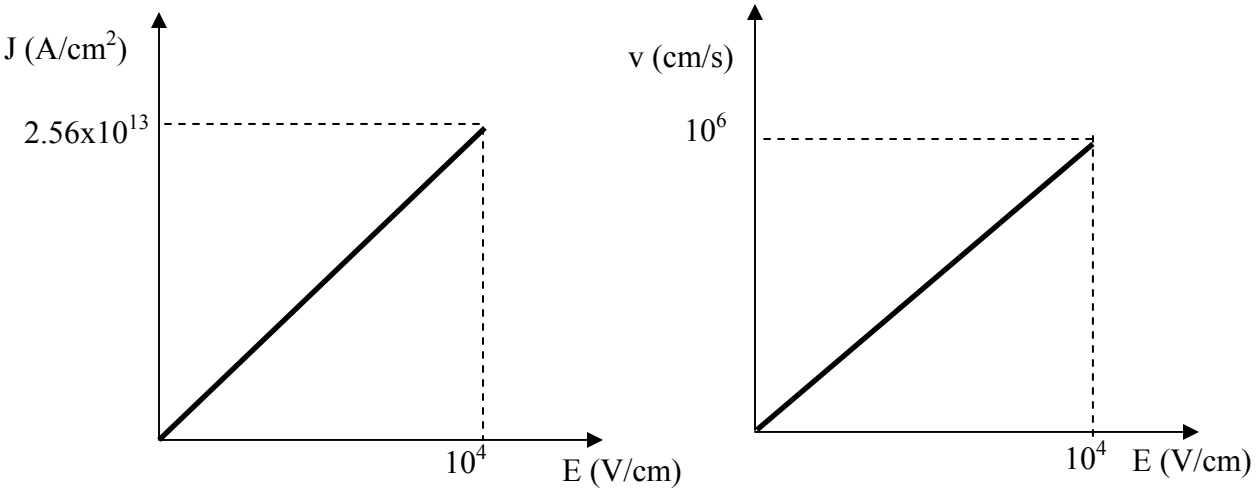
3.225 Quiz 2006

$e=1.602\times10^{-19}$ C $m_o=9.11\times10^{-31}$ kg $c=2.998\times10^{8}$ m/sec $\varepsilon_o=8.854\times10^{-12}$ F/m

$k_b=1.38\times10^{-23}$ J/K $h=6.626\times10^{-34}$ J-sec $\hbar=1.054\times10^{-34}$ J-sec $A=6.022\times10^{23}$ mole^{-1}

1. Classical Drude

The following information is given about an unknown material:



We do know that the structure is simple cubic and it has a lattice **a**=0.5nm.

a) Using the Classical Drude model, determine the valence of the atoms in this material.

b) Re-draw on the plots above J vs. E and v vs. E for the case in which the valence is now 3 and structure is BCC.

2. Models for Electron Gas

Describe the evolution of our models for electron gases as we have covered in 3.225. For each model (or improvement):

a) Explain reason for or basis for the model
b) Explain the improvements created by the model
c) Explain the materials properties and types of materials or compounds that can be modeled well with the assumptions in the model
d) Explain what the model can not describe sufficiently and what materials or compounds which remain elusive in terms of explanation with the model

3. Design of a Semiconductor Electrode

You are designing a GaP electrode for a yellow-emitting LED. GaP has a band gap of 2.2 eV. Assume the electron mobility is 1000 cm^2/V-s, and the hole mobility is 100 cm^2/V-s. Assume that $m=m_0$ and $\varepsilon_r \sim 10$.

a) Indicate the desired doping to maximize conductivity of the electrode as well as light transmission. What elements would you use to dope the GaP?

b) Sketch ε vs. ω for your electrode material over the important frequency range and indicate key values.

4. Cubic Ferroelectric

A cubic ferroelectric material has a saturated dipole moment **p**=1.6x10^{-30} C-m per unit cell. The lattice parameter **a**=0.5nm. Additional information is that ω_{oi}~10^{13} Hz and the index of refraction **n**=3. It takes an electric field **E**=10^{4} V/cm to saturate the ferroelectric.

a) Draw |**P**| vs. |**E**| and indicate key values.

b) If most of the polarization comes from ionic polarization, sketch ε_r vs. ω from 0 to infinity. Indicate key values.