EECS170A Fall 2004 **2nd Midterm Exam** Name:_____

11-09-2004 ID no.:_____

Sec.B: Peter Burke 3:30 to 4:50 pm

1A	1B	2	3A	3B	3C	3D	3E	Total
/15	/15	/20	/10	/10	/10	/10	/10	/100

THREE PROBLEMS TOTAL.

DO NOT BEGIN THE EXAM UNTIL YOU ARE TOLD TO DO SO.

PROBLEM ONE: (30 points)

1) For a piece of Si at 300 K, $N_D = 10^{17}$ cm^{-3}:
   a. Find the mobility μ_n of electrons to within 10% (15 points)

   b. Find the diffusion constant D_N of electrons to within 10% (15 points)

PROBLEM TWO: (20 points)

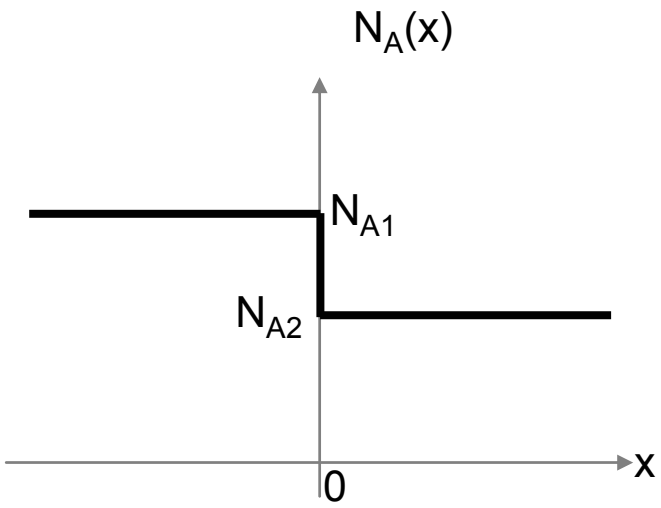
Some baseline temperatures in the three temperature scales:

temperature	kelvins	degrees Celsius	degrees Fahrenheit
symbol	**K**	**°C**	**°F**
boiling point of water	373.15	100.	212.
melting point of ice	273.15	0.	32.
absolute zero	0.	-273.15	-459.67

2) A p-n diode is reverse biased at – 1 V and cooled to the temperature of the melting point of ice (T = 273 K). At that temperature, the current is 1 pA.

The diode is now put into a pot of boiling water, so that its temperature is 373 K.
What is the current now, assuming the voltage is still – 1 V?

PROBLEM THREE: (50 points)



In class we considered a p-n junction. Now, I want you to consider a p-p junction, as shown in the graph above.

3) For a piece of Si with doping profile shown in the graph above,
   a. Draw the equilibrium energy band diagram for the junction, taking the doping to be nondegenerate and $N_{A1} > N_{A2}$. (10 points)

PROBLEM THREE: (50 points)

b. Derive an expression for the built-in voltage (V_{bi}) that exists across the junction under equilibrium conditions. (10 points)

c. Sketch the electric field as a function of position under equilibrium conditions. (10 points)

PROBLEM THREE: (continued)

d. Sketch the electrostatic potential (voltage) V(x) as a function of position under equilibrium conditions. (10 points)

e. Sketch the total charge density $\rho(x)$ as a function of position under equilibrium conditions. (10 points)