Name: Email:
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UNIVERSITY OF CALIFORNIA
Department of Electircal Engineering and Computer Sciences
EE 130 Fall 2003
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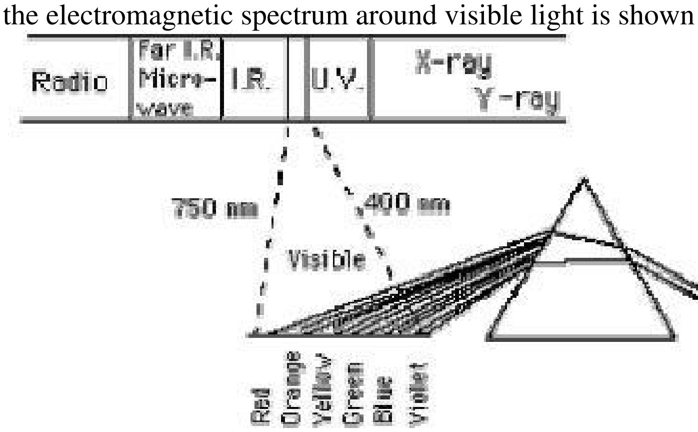
Test #1

1)Consider the following elements:
Zn: Atomic number: 30, Atomic weight: 65
O: Atomic number: 8, Atomic weight: 16

a) Write the electronic configurations (1s2, 2s2, …) for both elements (2pts)

b) Two Zinc Oxides are known to exist. ZnO and ZnO2. Which material is likely to be a semiconductor? Why? (1 pt)

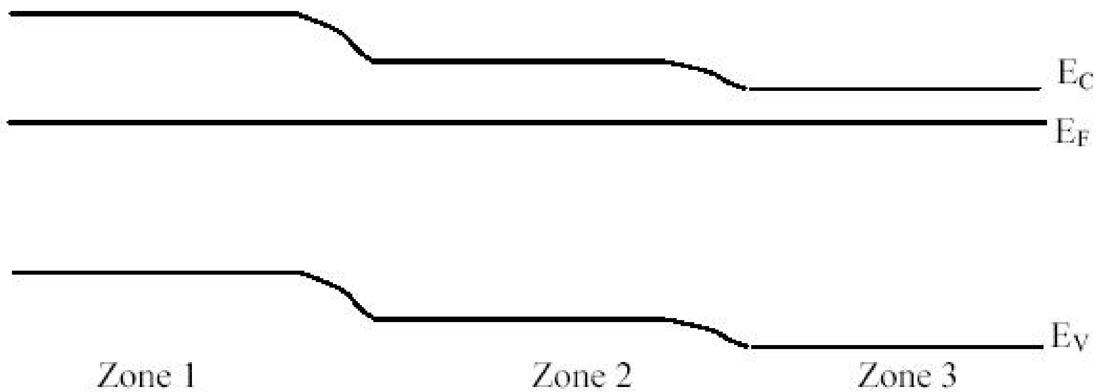
c) The portion of the electromagnetic spectrum around visible light is shown below.



Frequencies: 4 - 7.5 x 10^14 Hz
Wavelengths: 750 - 400 nm
Quantum energies: 1.65 - 3.1 eV

The Zinc Oxide semiconductor from above is known to be almost entirely transparent to visible light, yet, also forms a decent semiconductor at room temperature. Suggest a likely bandgap for the material. Give reasons for your answer. (2 pts)

2) Consider a block of silicon that is doped into three zones, each 1cm long with phosphorus concentrations of 1E16, 1E17, and 1E18 cm-3 respectively.



a) Based on the band diagram above, determine which doping level corresponds to each zone (1.5 pts)

i) Zone 1:

ii) Zone 2:

iii) Zone 3:

b) What is the voltage applied across the piece of silicon above? Give reasons. (1 pt)

c) Estimate the resistances of the three zones, assuming the cross-sectional area is 1cm×1cm. Ignore the curved regions on the band diagram above: (1.5 pts)

i) Zone 1:

ii) Zone 2:

iii) Zone 3:

d) Suppose I apply 0.6V across the block, with the anode connected on the left. Sketch the resulting band diagram, indicating the approximate voltage drop across each region. (4 pts)

3) Suppose I take a block of silicon and dope it with 1E17cm-3 Arsenic.

a) What is the concentration of electronics and holes at room temperature? (1 pt)

b) Now, suppose I add 1E18cm-3 Indium to this block. Will the resulting material be Ntype, intrinsic, or P-type. Give reasons. (2 pts)

c) Which dopant will be more completely ionized. Why? (2 pts)

d) Now, suppose I add an additional 1E19cm-3 of Indium. Will the %ionization of Indium Increase or decrease. Sketch a plot of the Fermi function in the two cases to illustrate your answer. (3 pts)

e) Suppose I were to have used Boron instead of Indium in parts (b) and (d) above. Would the resistance of the block increase, decrease, or stay the same. Give reasons for your answer. (2 pts)

f) Compare the hole mobility of two identical blocks of silicon at room temperature. Block "A" is moderately doped (~1E17 or so) with Boron, while Block "B" is doped with an identical amount of Indium. Give reasons for your answer. (2 pts)