



### Sheet #3

#### TextBook

'Principles of Electronic Materials and Devices', Third Edition, S.O. Kasap © McGraw-Hill, 2006

#### Constants:

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ Fm}^{-1}$$

$$\text{Charge of electron } (q) = 1.6 \times 10^{-19} \text{ C}$$

$$\text{Mass of electron } (m_e) = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{Plank's Constant } (h) = 6.63 \times 10^{-34} \text{ Js}$$

#### Choose the correct answer justifying your choice:

- Doping silicon with Aluminum results in .....
  - n-type semiconductor
  - p-type semiconductor
  - intrinsic semiconductor
  - non-conducting material
- Doping silicon with phosphorous results in .....
  - n-type semiconductor
  - p-type semiconductor
  - intrinsic semiconductor
  - non-conducting material
- In an intrinsic semiconductor .....
  - There is no allowed energy levels between  $E_c$  and  $E_v$ .
  - There is an allowed energy level which is little above  $E_v$ .
  - There is an allowed energy level which is little below  $E_c$ .
  - There is an allowed energy level which is near the middle between  $E_c$  and  $E_v$ .
- In an n-type semiconductor .....
  - There is no allowed energy levels between  $E_c$  and  $E_v$ .
  - There is an allowed energy level which is little above  $E_v$ .
  - There is an allowed energy level which is little below  $E_c$ .
  - There is an allowed energy level which is near the middle between  $E_c$  and  $E_v$ .
- In a p-type semiconductor .....
  - There is no allowed energy levels between  $E_c$  and  $E_v$ .
  - There is an allowed energy level which is little above  $E_v$ .
  - There is an allowed energy level which is little below  $E_c$ .
  - There is an allowed energy level which is near the middle between  $E_c$  and  $E_v$ .
- The electron and hole concentrations are equal to zero .....
  - in an intrinsic semiconductor.
  - in an extrinsic semiconductor.
  - in a semiconductor at 0 K temperature.
  - in a semiconductor at very high temperature.
- In an intrinsic semiconductor, if  $n$  and  $p$  are the electron and hole concentrations.....

- (a)  $n$  must be zero                      (b)  $p$  must be zero  
(c)  $n$  and  $p$  must be equal              (d)  $n$  and  $p$  must not be equal

8. In an n-type semiconductor, if  $n$  and  $p$  are the electron and hole concentrations, .....

- (a)  $n$  must be zero                      (b)  $p$  must be zero  
(c)  $n$  is smaller than  $p$                 (d)  $n$  is larger than  $p$

9. In a p-type semiconductor, if  $n$  and  $p$  are the electron and hole concentrations, .....

- (a)  $n$  must be zero                      (b)  $p$  must be zero  
(c)  $n$  is smaller than  $p$                 (d)  $n$  is larger than  $p$

**Solve the following problems:**

- [1] Find the electron and hole concentration if silicon with intrinsic concentration ( $n_i$ ) of  $1.5 \times 10^{10} \text{ cm}^{-3}$  is doped with:  
a.  $5 \times 10^{22} \text{ m}^{-3}$  Boron atoms.  
b.  $2 \times 10^{16} \text{ cm}^{-3}$  Phosphorus atoms.

[2] Plot the energy band diagram for:

- a. Silicon.  
b. Germanium.

(Vacuum Level, Electron Affinity and Energy Band Gap should be clearly depicted.)