

fundamentals of electronic circuits

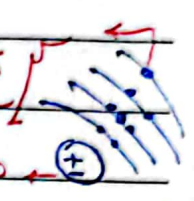
Classification of materials.

A. Conductors $\rho \rightarrow 10^{-4} \rightarrow 10^{-8} \Omega \cdot \text{cm}$

plenty of Free elec

التيار هو من الالكترونات يتدفق

valence electrons



Excitation
Temp Elec field E

B. Isolator

يوجد به انجذاب قوي

$\rho \rightarrow 10^8 \rightarrow 10^{18} \Omega \cdot \text{cm}$

C. Semi Conductors.

يوجد توصيل ضعيف $\rho \rightarrow 10^{-4} \rightarrow 10^8 \Omega \cdot \text{cm}$

$10^{23} \text{ atom/cm}^3$ \rightarrow Germanium

per Sec $10^{10} \text{ atom/cm}^3$

n-type \leftarrow + Phosphorus

p-type \leftarrow + Boron

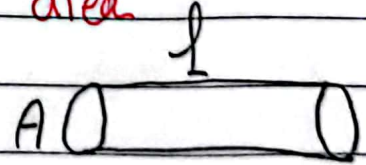
Doping

فلاشي

$$R = \rho \frac{l}{A}$$

resistivity

cross-section area



كل cond. فيه

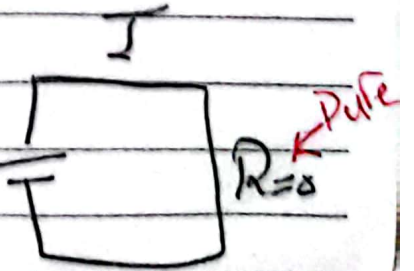
سوابب

Copper نحاس
Aluminum ألومنيوم
Iron حديد
Silver فضة
Gold ذهب

Short circuit

$$I = \frac{V}{R}$$

$0 \leftarrow R$

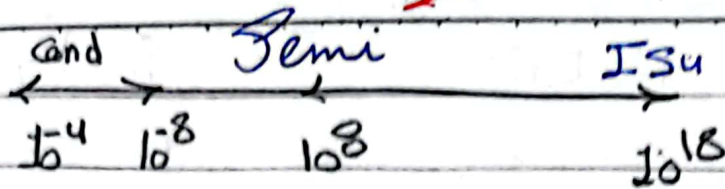


resistivity

conductivity

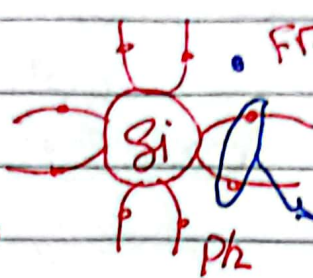
Number

in between



n.type

بعد اتمام اذنه افسفور
وفرة من الالكترونات

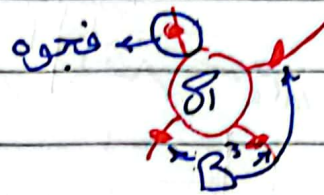


$$10^{10} + 10^{16} \approx 10^{16}$$

covalent bond

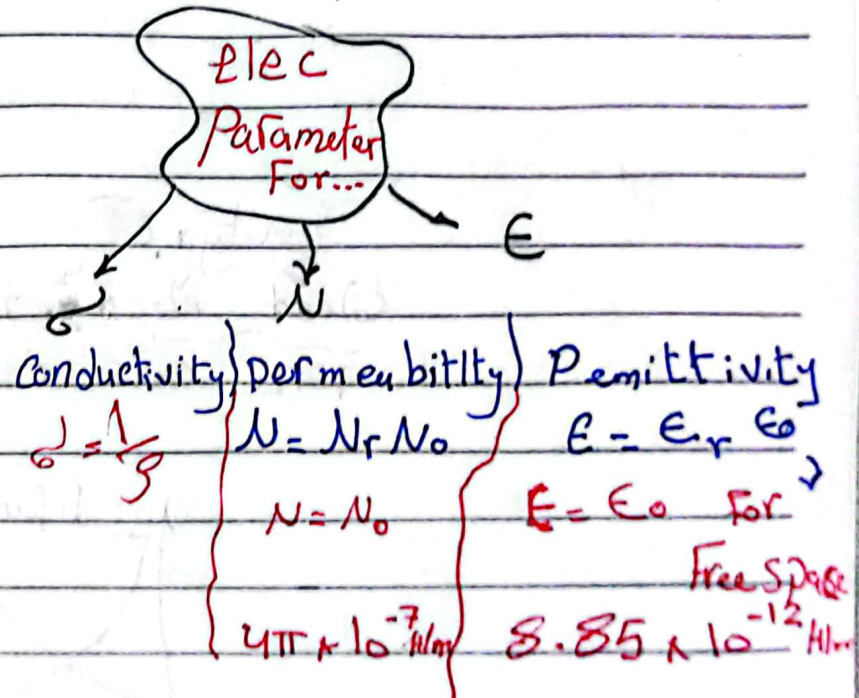
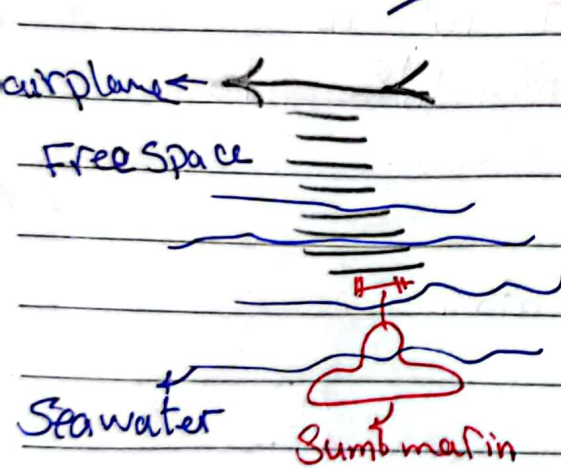
رابطة تساهمية

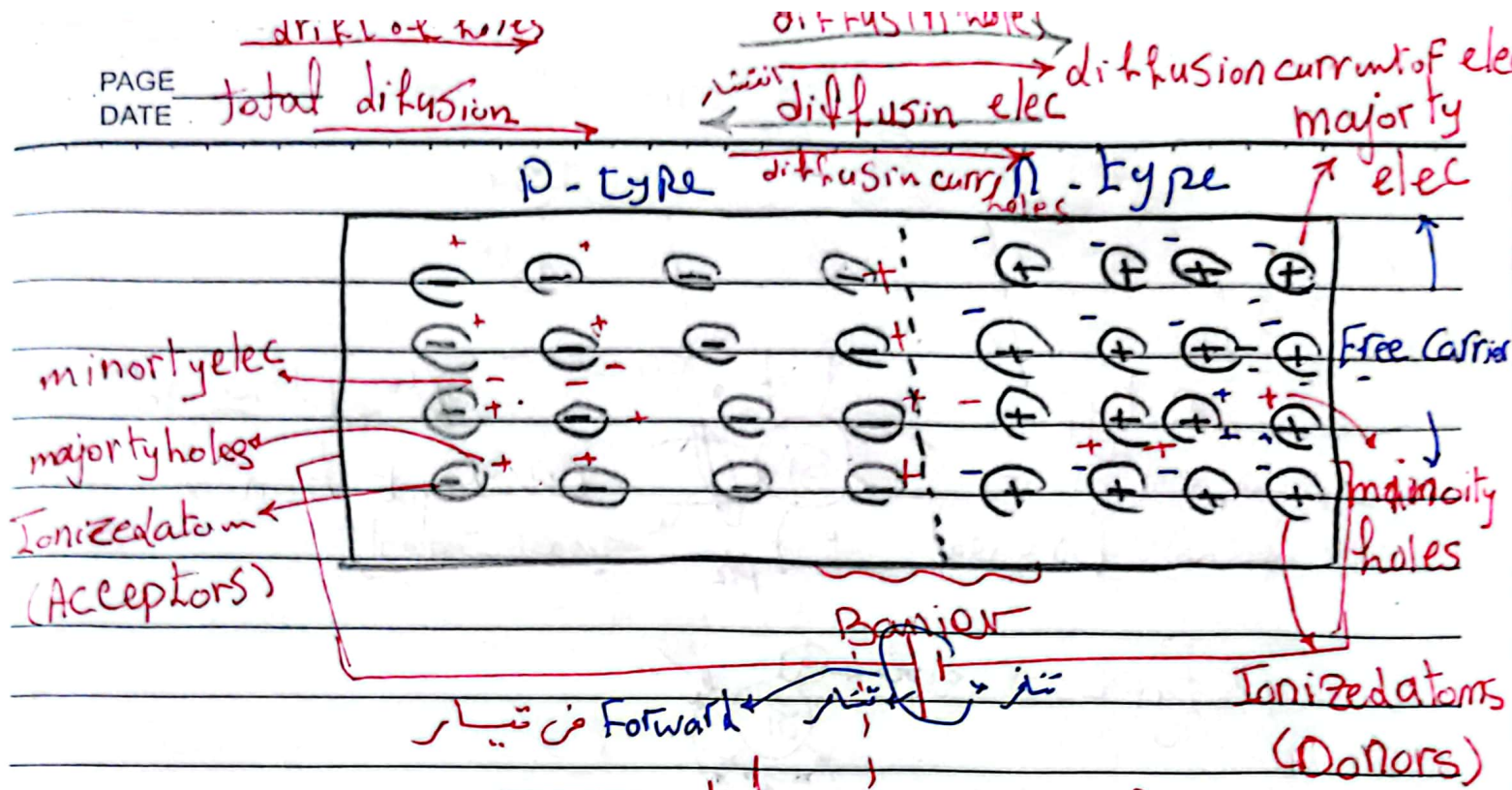
p.type



Conductivity p.type n.type

الخواص الكهربائية للمواد





Rever

majority holes
 $10^{23} / \text{cm}^3$
 $10^{16} / \text{cm}^3$
p n

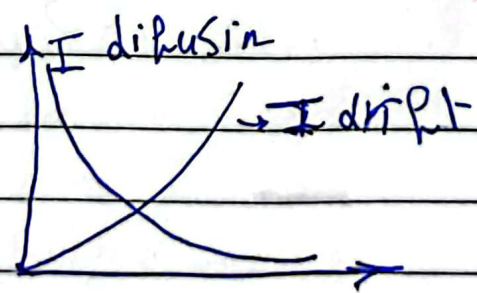
$$T \quad 10^{16} \quad n$$

$$10^{16} + 10^{10} \approx 10^{16}$$

n-type

holes + elec → Ionized atom

Free carrier



1. For n type SemiCon

majority elec , minority holes

2. For p type Semi

majority ~~elec~~ holes , minority elec

3. Depletion region

Ionized atom

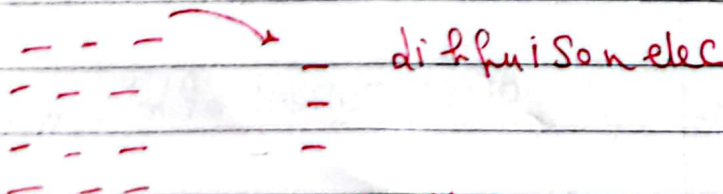
Imagined ionized atom (acceptors, Donors)
immobile atoms

Free from elec and holes

4. The contribution of ionized atom gives E
while the contribution of free carriers (holes, elec)
gives current

diffusion → drift

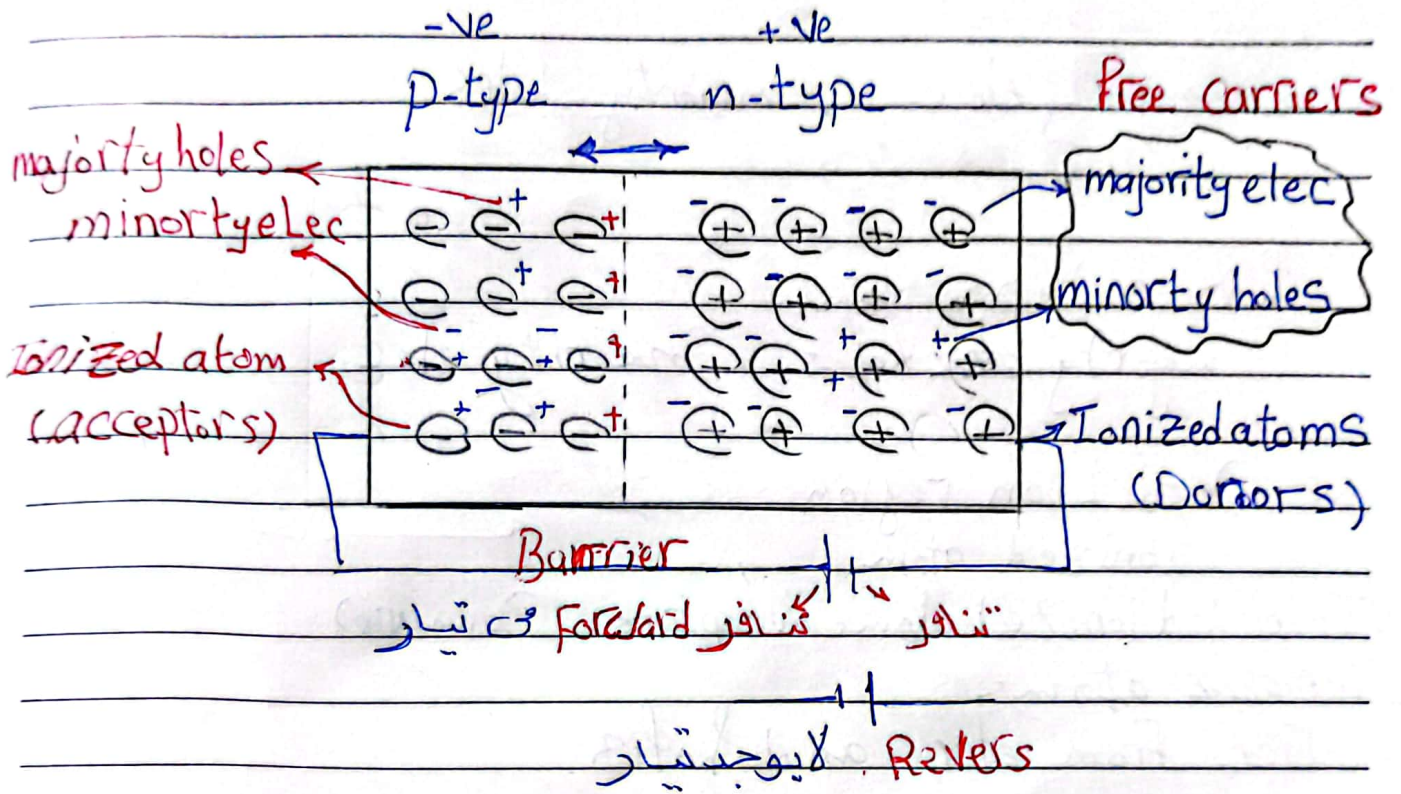
holes



drift → Donors (ionized atom)

drift → Acceptors

diffusion



p diffusion of current elec n (2)

p ← diffusion of elec n (1)

p diffusion of current of holes n (4)

p diffusion holes → n (3)

p drift of elec → n (6)

p total diffusion current n (5)

p ← drift of holes n (8)

p drift of current elec n (7)

p ← total drift current n (10)

p ← drift current of holes n (9)

* n-type
↑ elec ↓ holes
free carrier

p-type
↓ elec ↑ holes
Ionized atom