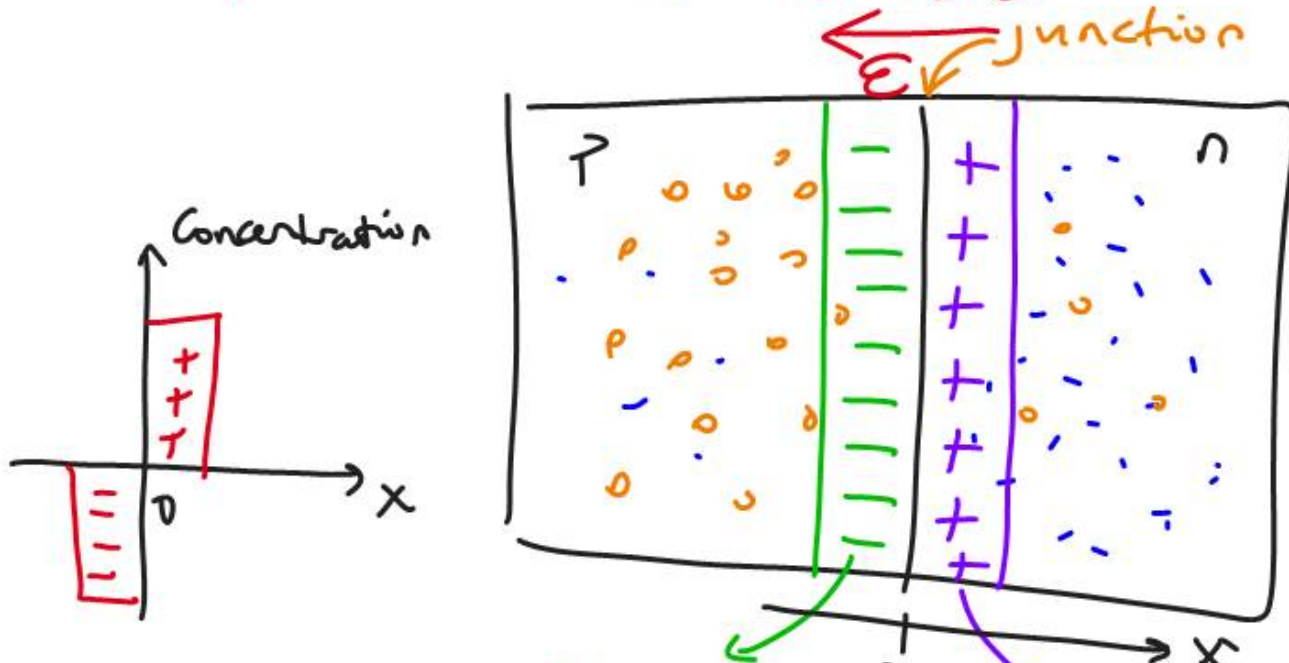


# PN JUNCTION DIODE

21.02.2011

©



Acceptors  
Group III impurities  
(Al, Ga, In...)

Donors  
Group V impurities  
(As, P, Sb...)

form a space charge

$$\vec{F}_{IV} = q (\vec{v}_x \times \vec{B} + \vec{E})$$

$$\vec{F}_{II} = q \vec{E}$$

$$F = -q E \text{ for electrons}$$

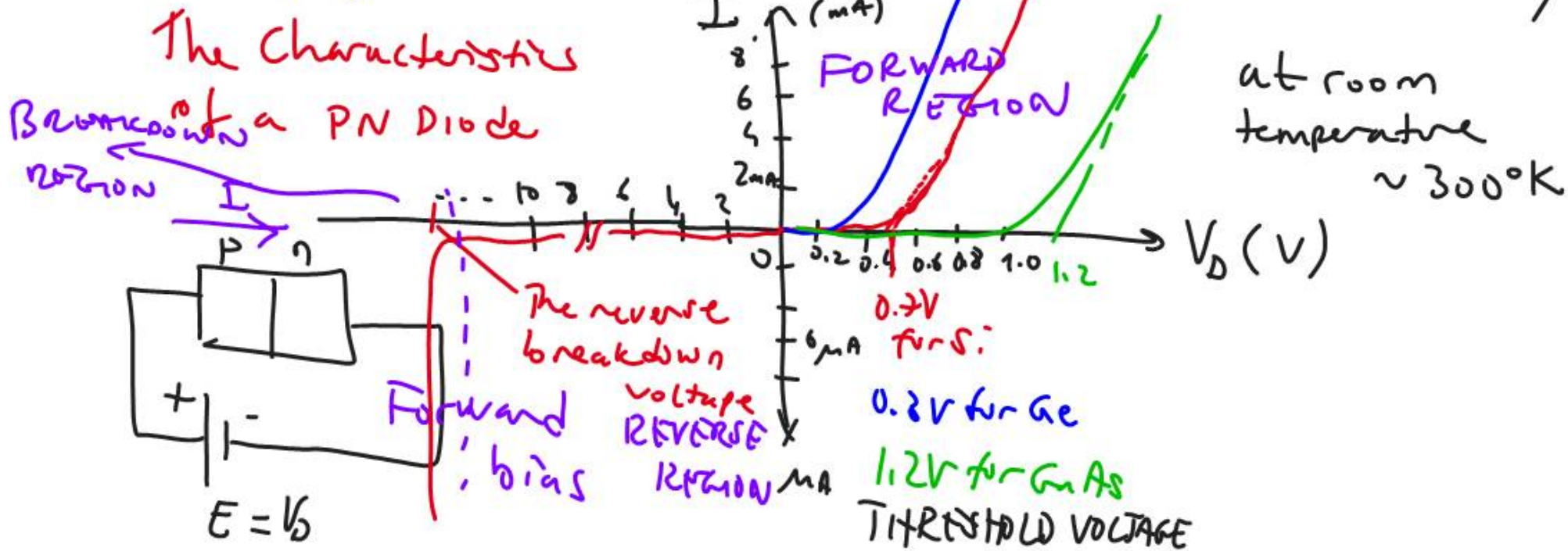
$$F = q E \text{ for holes}$$

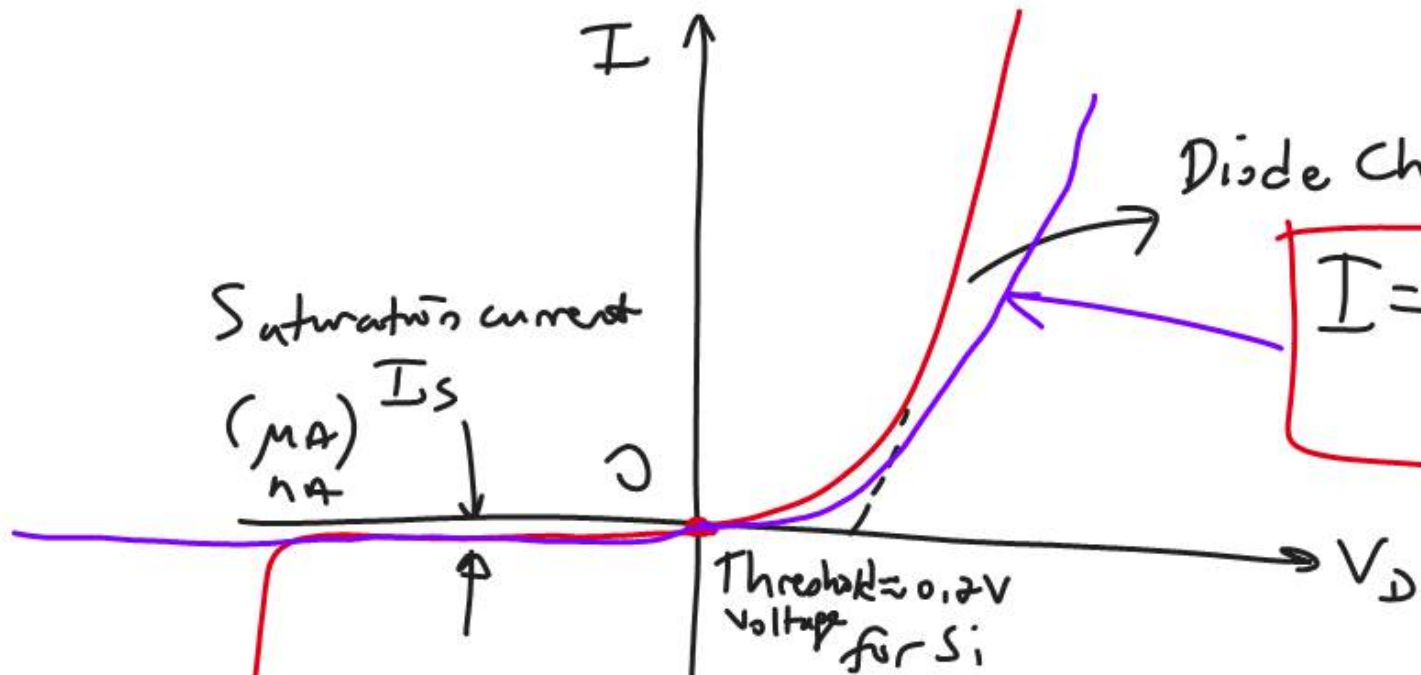
$1.6 \times 10^{-19} \text{ C}$



If we have no output excitation there will be no carrier movement any more when the built-in electric field ( $E$ ) is formed. No current passes.

To have current in a pn junction diode we have to apply a proper voltage (an external excitation)





Diode equation

$$I = I_s (e^{V_D/V_T} - 1)$$

$I_s$  saturation current

$V_T =$  Thermal voltage

$$V_T = \frac{kT}{q}$$

$k$ : Boltzmann Constant  
 $T$ : Temperature ( $^{\circ}K$ )  
 $q$ : unit charge ( $1.6 \times 10^{-19} C$ )

$V_T = 26 mV$

Saturation current  
 (mA)  $I_s$   
 nA

Threshold  $\approx 0.2V$   
 voltage for Si

$$I = I_s (e^{V_D/V_T} - 1)$$

when  $V_D = 0 \Rightarrow I = 0$

when  $V_D < 0 \Rightarrow I \approx -I_s$  at  $T = 300^{\circ}K$