5 Oct 2016

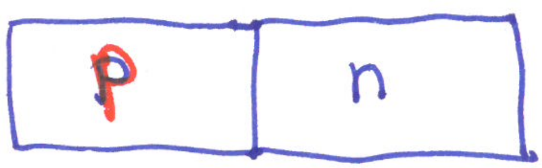
$$N_A + n = N_D + p$$

	N_A	n	N_D	p
N-Type	0?	$\uparrow\downarrow$	$\uparrow$	$\downarrow$
p-type	$\uparrow$	$\downarrow$	0?	$\uparrow\downarrow$

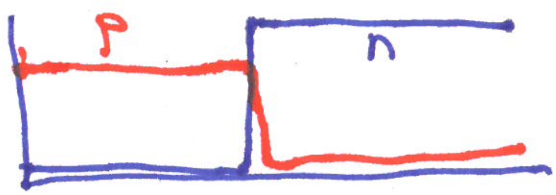
N-Type $n = N_D - N_A + p \approx N_D$

P-type $p \approx N_A$

Junction



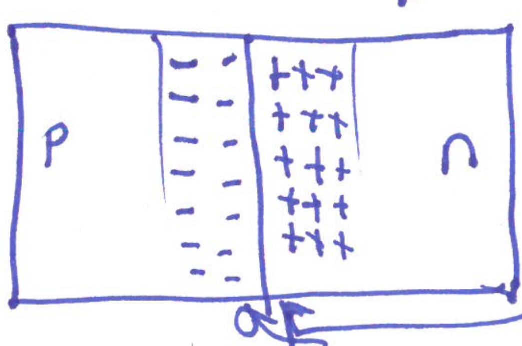
Concentration



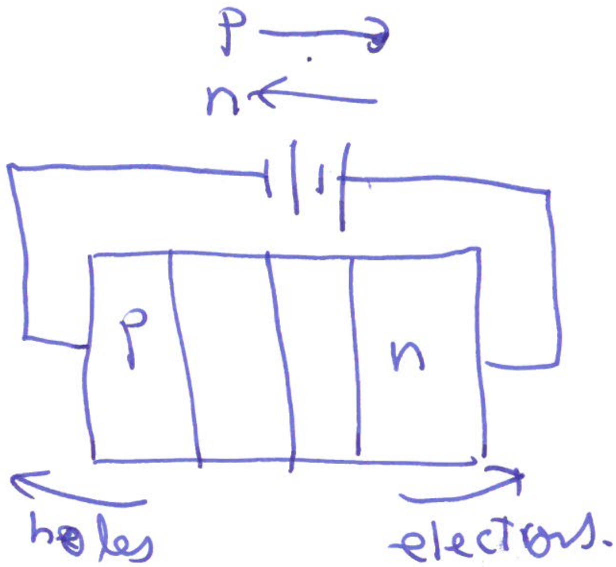
Diffusion Current

p $\longrightarrow$

$\longleftarrow$ n



Depletion Region

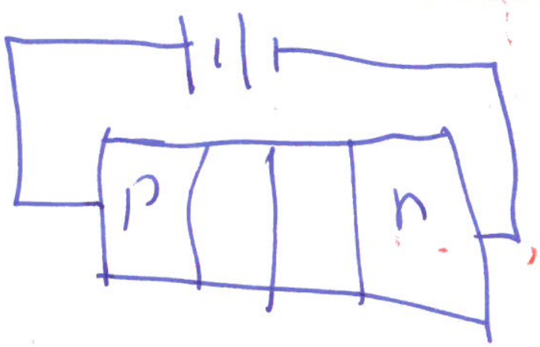


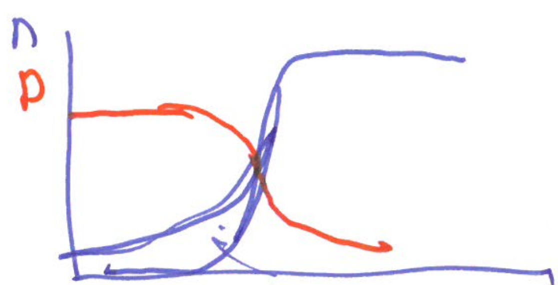
Wider Depletion Region

$$C = \frac{\epsilon A}{D}$$

Reverse Current

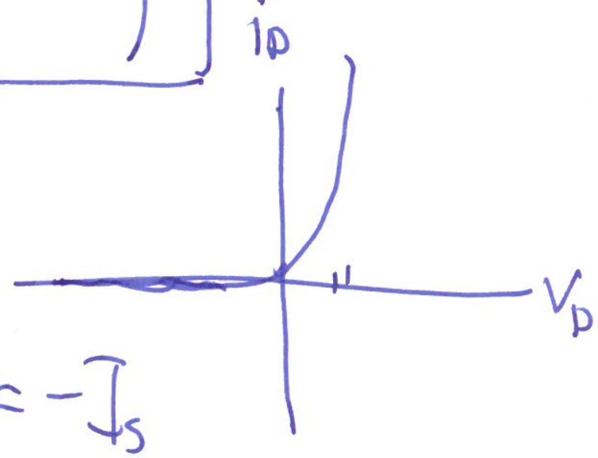
Saturation Current, I_S





Shockley Equation

$$\boxed{i_D = I_S\left(e^{\frac{V_D}{nV_T}} - 1\right)}$$



Reverse Bias $\quad i_D \simeq -I_S$

Forward Bias

$$i_D \simeq I_S e^{\frac{V_D}{nV_T}}$$

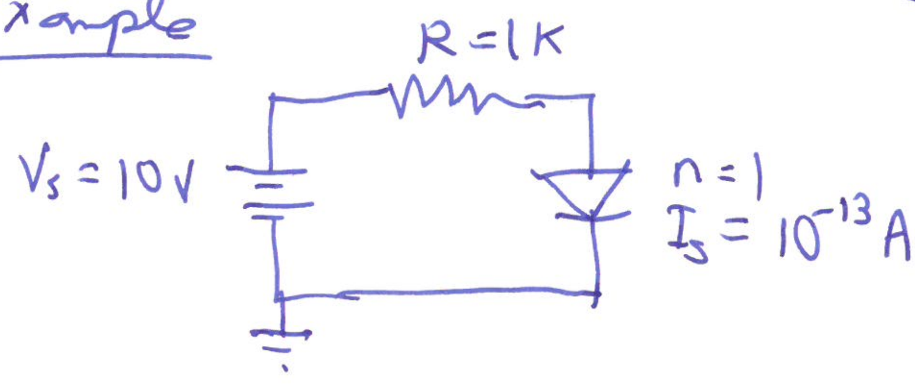
V_T = thermal voltage
25 mV @ room temp.

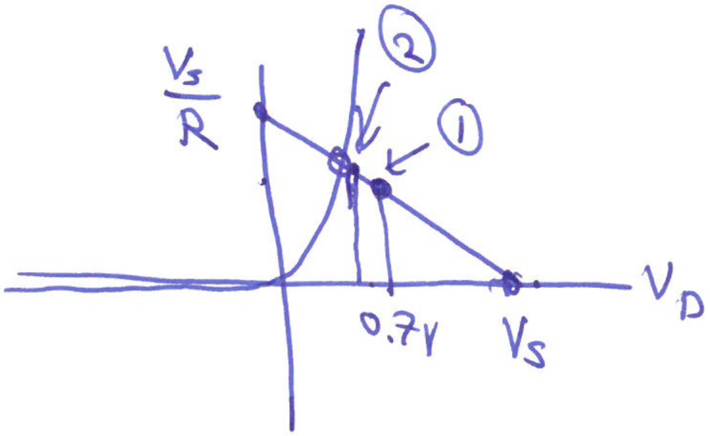
$1 < n < 2$

Use this equation carefully.

Usually solve for V_D

Example





Guess $V_D = 0.7\,V$

calculate $i_D = \dfrac{V_S - V_D}{R} = 9.3\,mA$ 1

use S.Eq. for V_D $\dfrac{V_D}{nV_T} = \ln \dfrac{i_D}{I_s}$

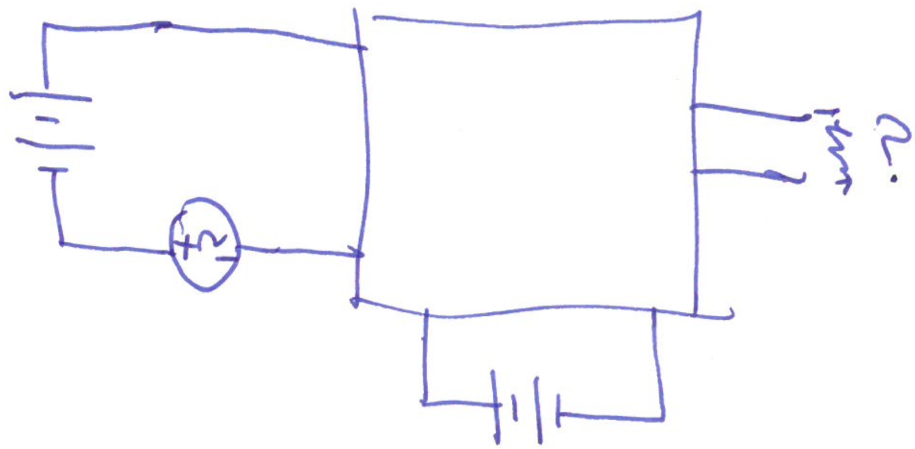
$V_D = nV_T \ln \dfrac{i_D}{I_S} = 0.6314\,V$ 1

Second Time

$i_D = 9.4\,mA$

$V_D = 0.6316\,\cancel{mA}\,V$ 2

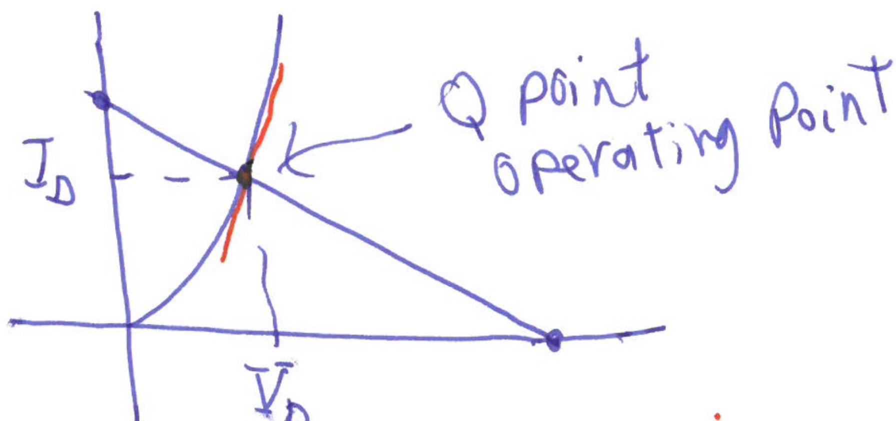
Small signal model



$$v_D = V_D + v_d$$

Total voltage — DC — AC

$$i_D = I_D + i_d$$



$$r_d = \left(\frac{di_D}{dV_D}\right)^{-1}$$