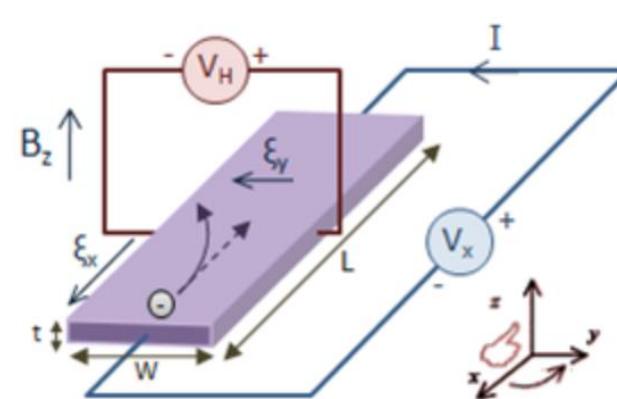
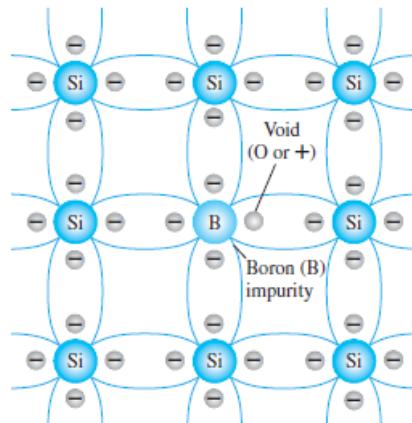
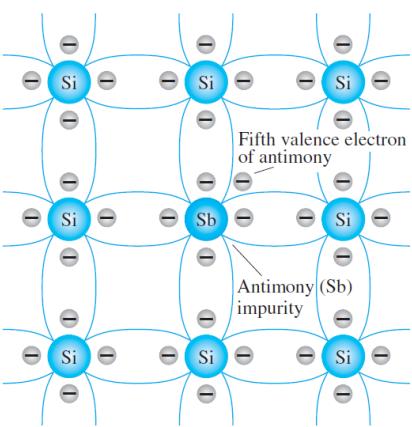
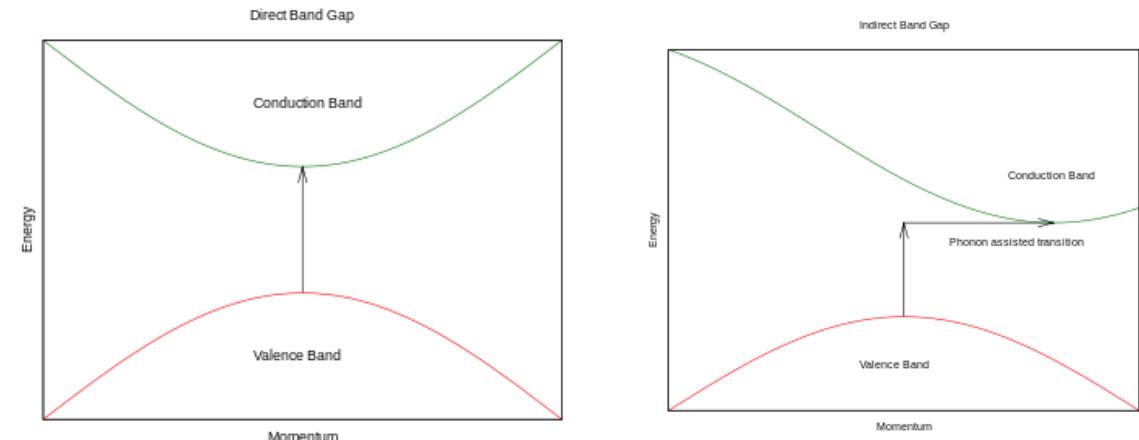
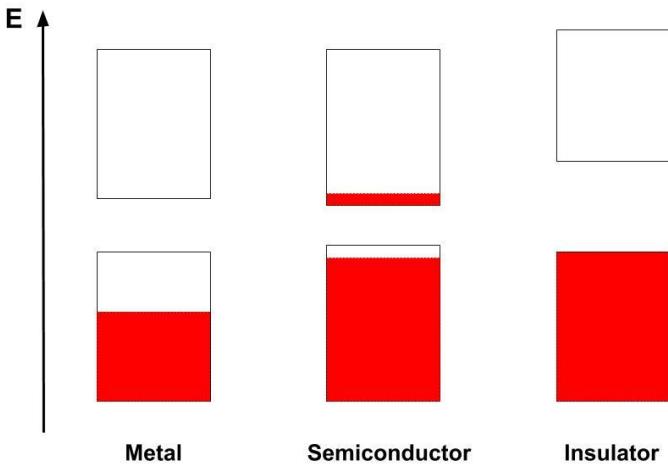
A large, abstract network graph is positioned on the left side of the slide. It consists of numerous small, semi-transparent colored circles (ranging from red to green) connected by thin, light-colored lines. The graph is roughly circular and has a organic, branching structure.

ECE 101

Fundamentals of Electronics

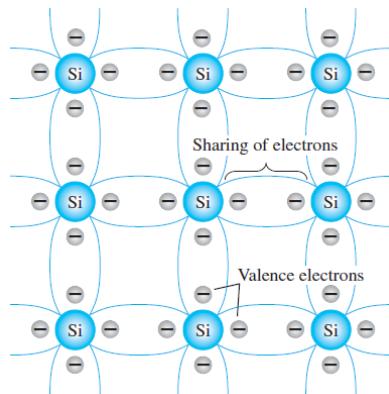
Review



$$V_H = \frac{I_x B_z}{n t e}$$

Summary

- Confinement leads to discretization
- When a lot of atoms come close to each other – bands are formed.



Intrinsic Carriers n_i

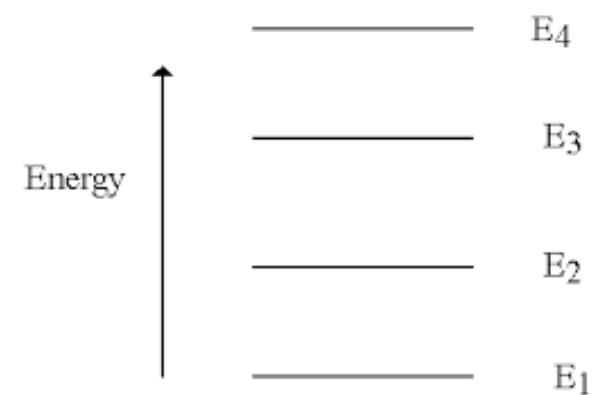
Semiconductor	Intrinsic Carriers (per cubic centimeter)
GaAs	1.7×10^6
Si	1.5×10^{10}
Ge	2.5×10^{13}

Relative Mobility Factor μ_n

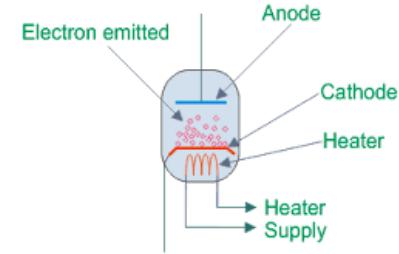
Semiconductor	μ_n ($\text{cm}^2/\text{V}\cdot\text{s}$)
Si	1500
Ge	3900
GaAs	8500

- Electrons and holes in semiconductors.

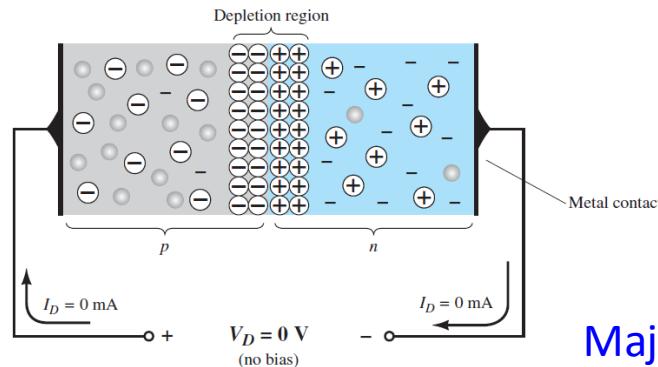
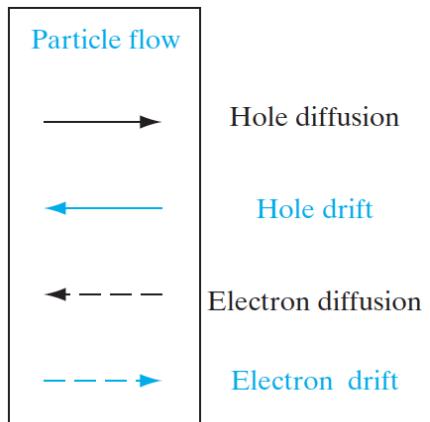
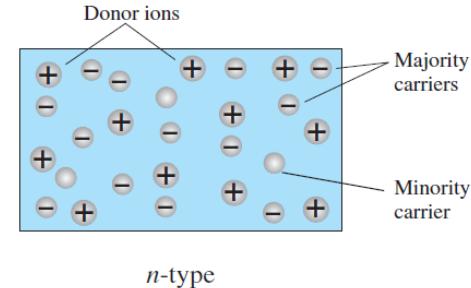
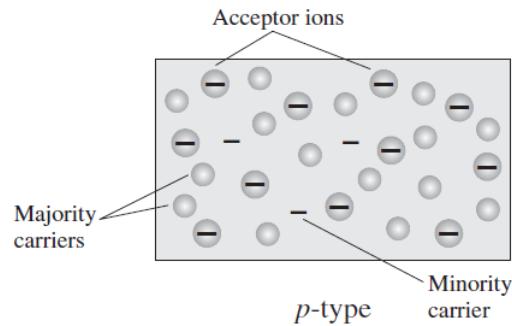
**Photoelectric effect
Quantum mechanics**



Diode: semiconductor junction



- Once we have both n-type and p-type materials available with us, what happens when we put two different kind of materials together.



Static and mobile charge.

$$J_p(\text{drift}) + J_p(\text{diff.}) = 0$$

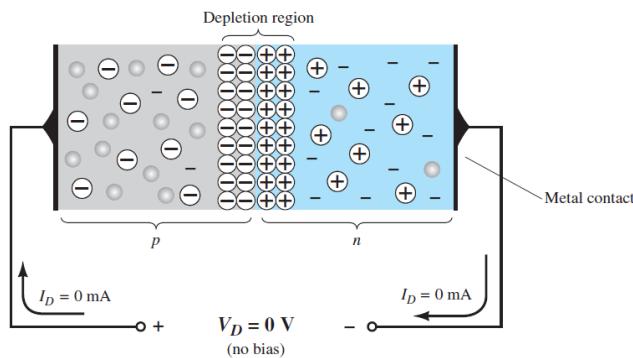
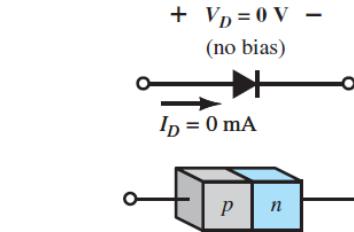
$$J_n(\text{drift}) + J_n(\text{diff.}) = 0$$

Majority and minority currents.

Equilibrium and steady state

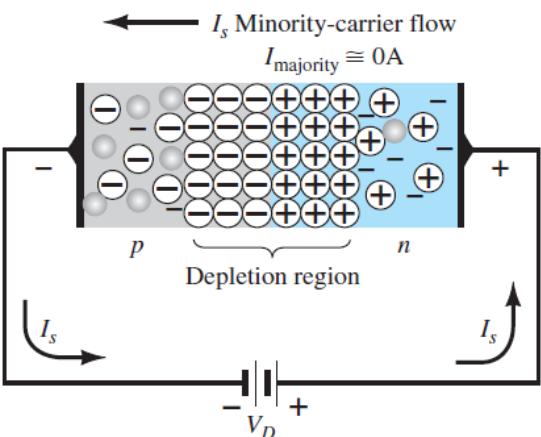
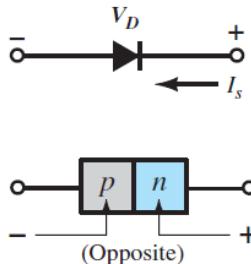
PN junction: under bias

No bias

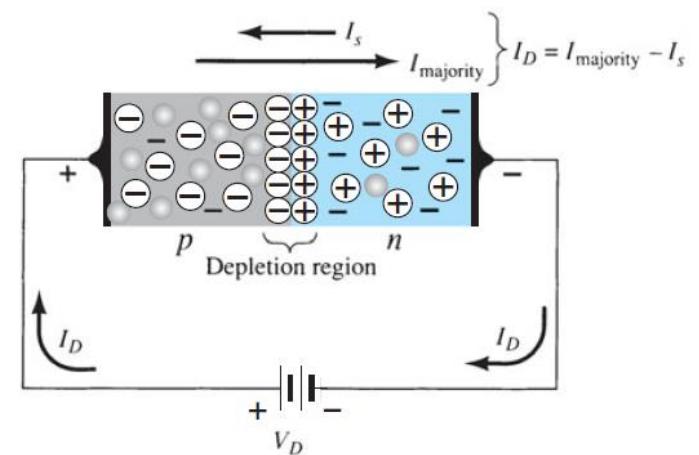
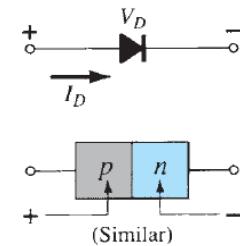


Depletion region

Reverse bias



Forward bias



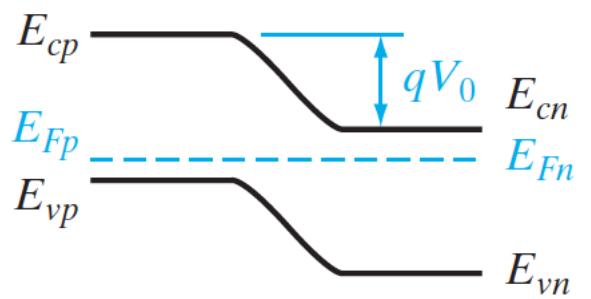
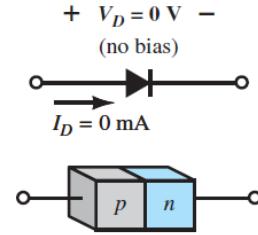
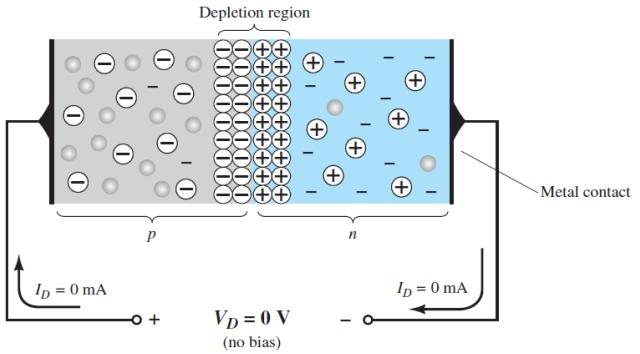
The current that exists under reverse-bias conditions is called the reverse saturation current: nA - μA

$$I_D = I_s(e^{V_D/nV_T} - 1)$$

n – ideality factor of diode

PN junction: diode

Equilibrium conditions

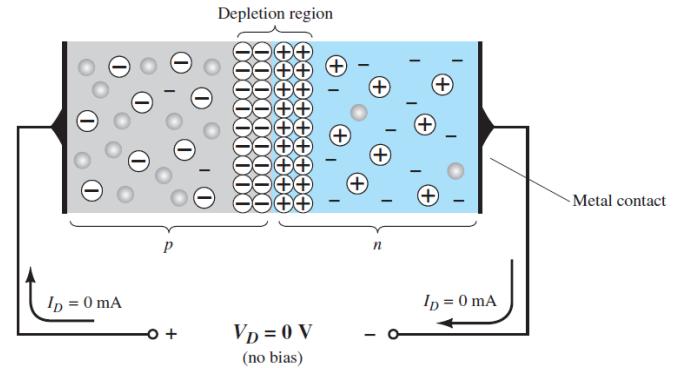
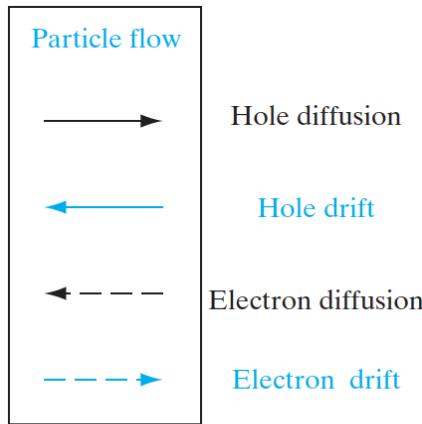
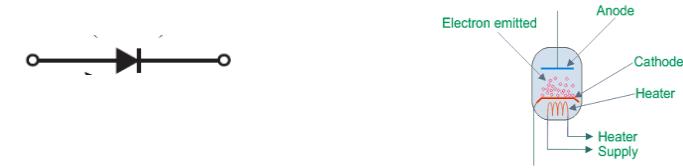
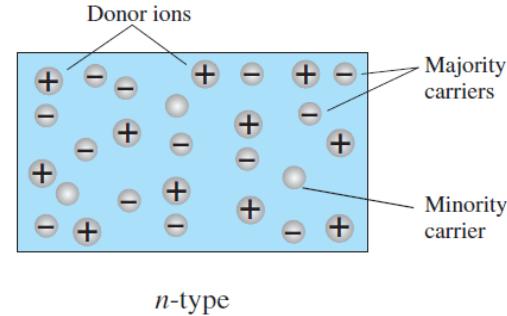
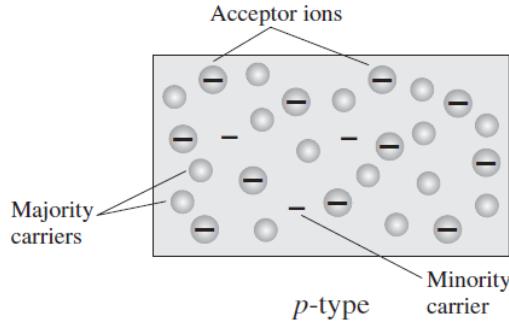


Depletion region

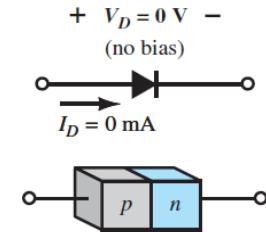
$$V_0 = \frac{kT}{q} \ln \frac{N_a}{n_i^2 / N_d} = \frac{kT}{q} \ln \frac{N_a N_d}{n_i^2}$$

$$W = \left[\frac{2\epsilon V_0}{q} \left(\frac{N_a + N_d}{N_a N_d} \right) \right]^{1/2} = \left[\frac{2\epsilon V_0}{q} \left(\frac{1}{N_a} + \frac{1}{N_d} \right) \right]^{1/2}$$

Summary



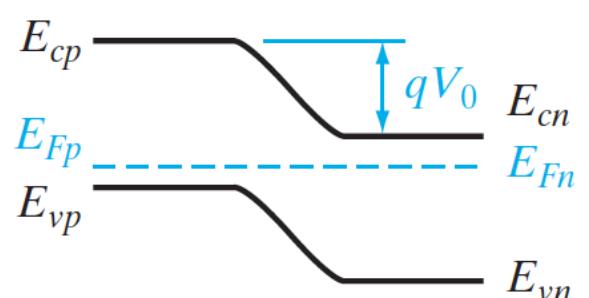
Equilibrium conditions



Static and mobile charge.

$$J_p(\text{drift}) + J_p(\text{diff.}) = 0$$

$$J_n(\text{drift}) + J_n(\text{diff.}) = 0$$



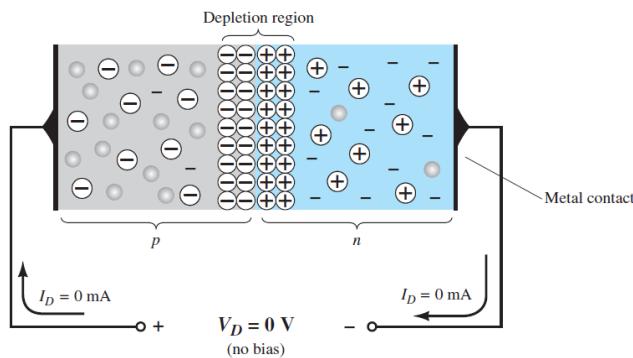
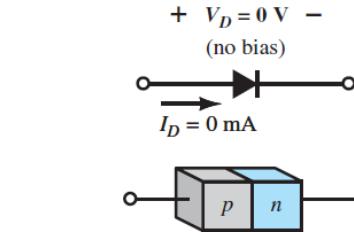
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Majority and minority currents.

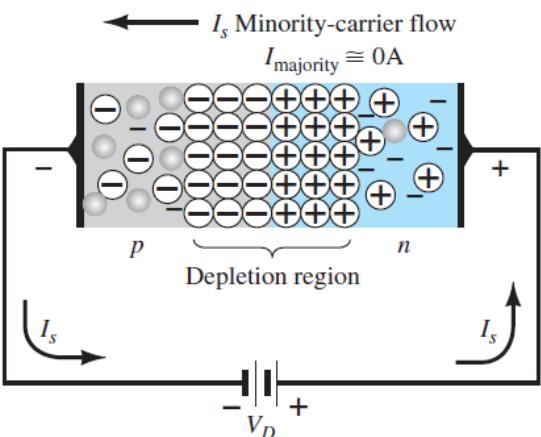
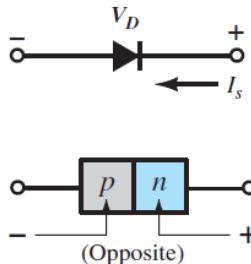
PN junction: under bias

No bias

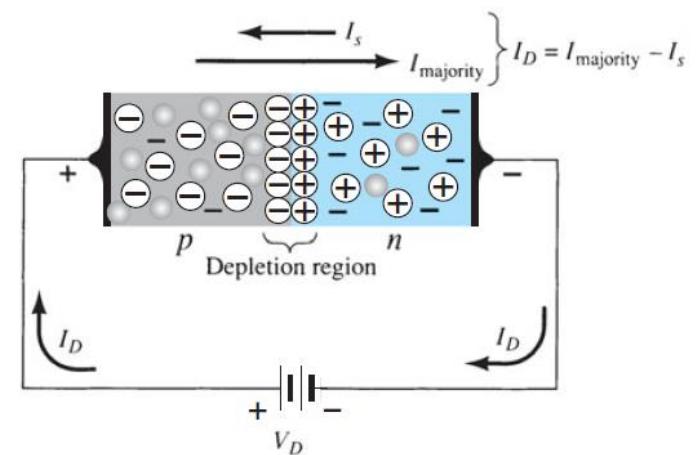
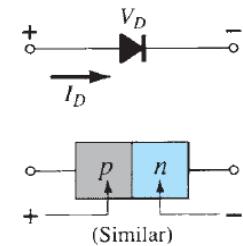


Depletion region

Reverse bias



Forward bias

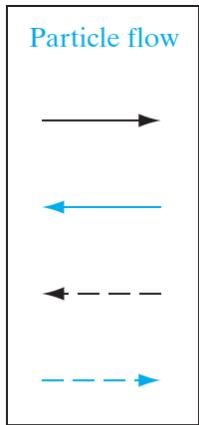
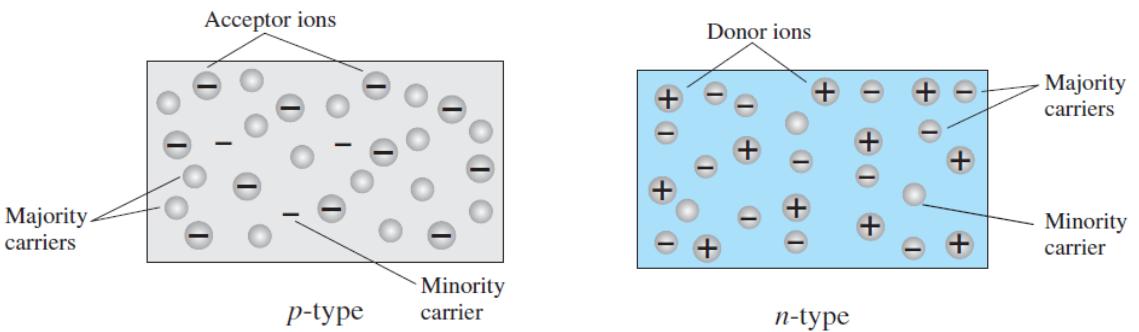


The current that exists under reverse-bias conditions is called the reverse saturation current: nA - μA

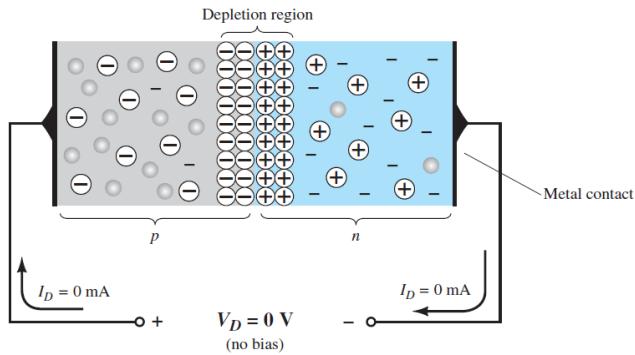
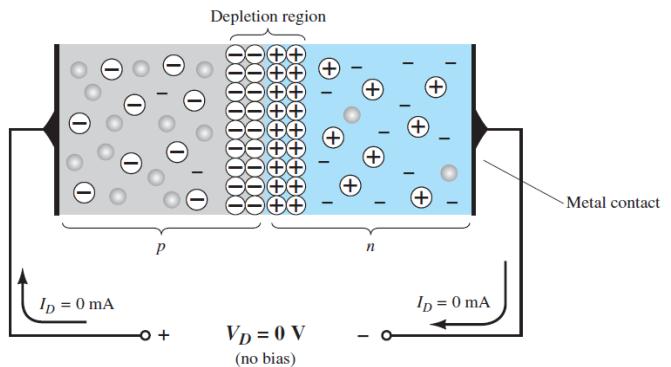
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n – ideality factor of diode

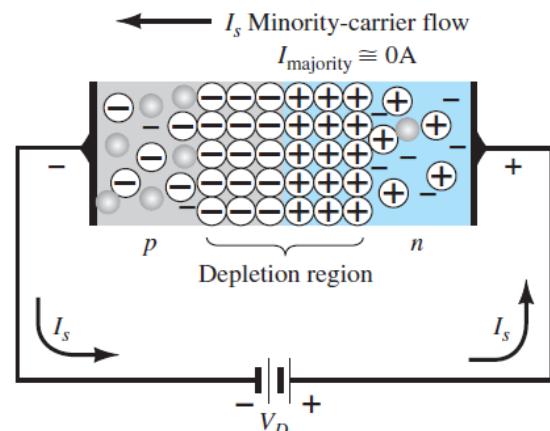
Review



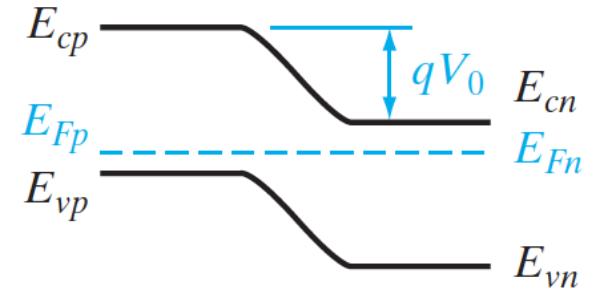
Hole diffusion
Hole drift
Electron diffusion
Electron drift



No bias

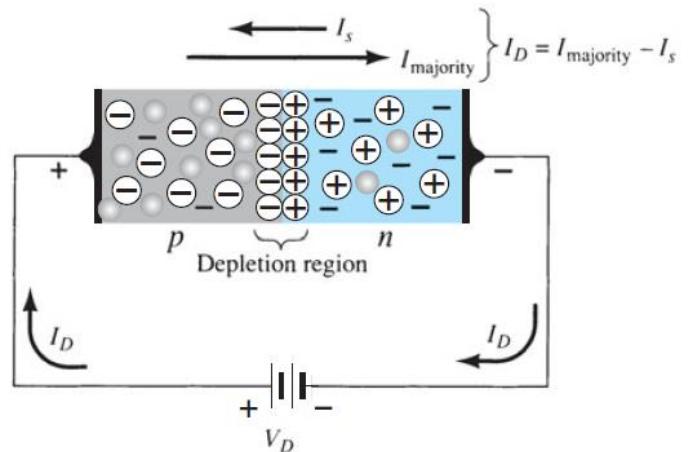


Reverse bias

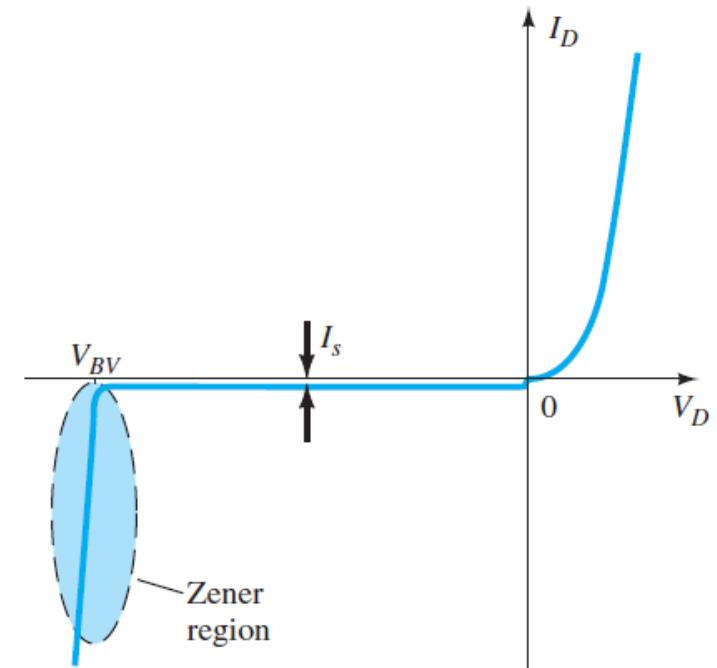
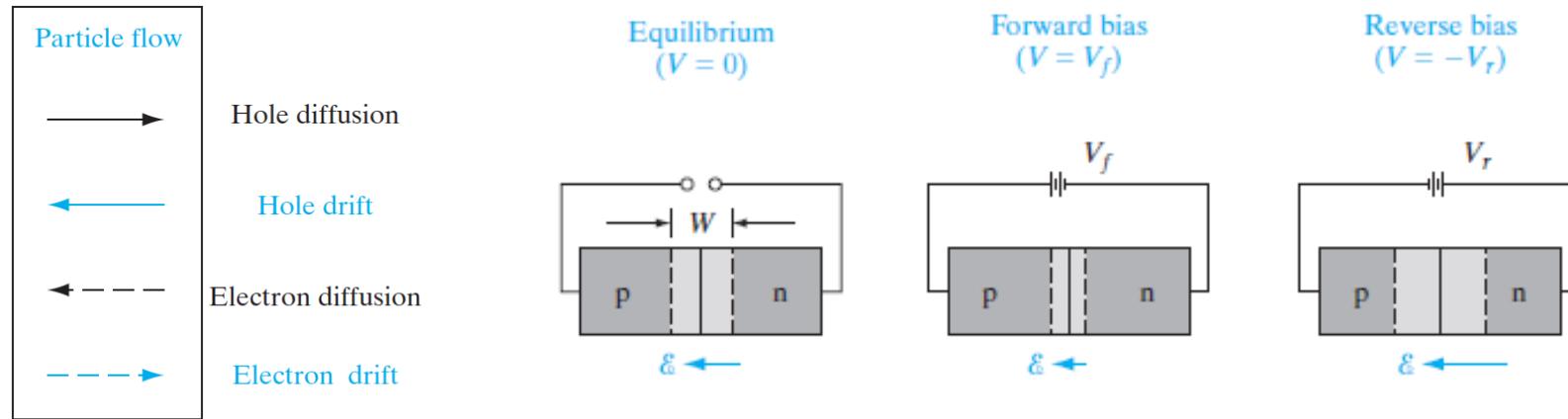


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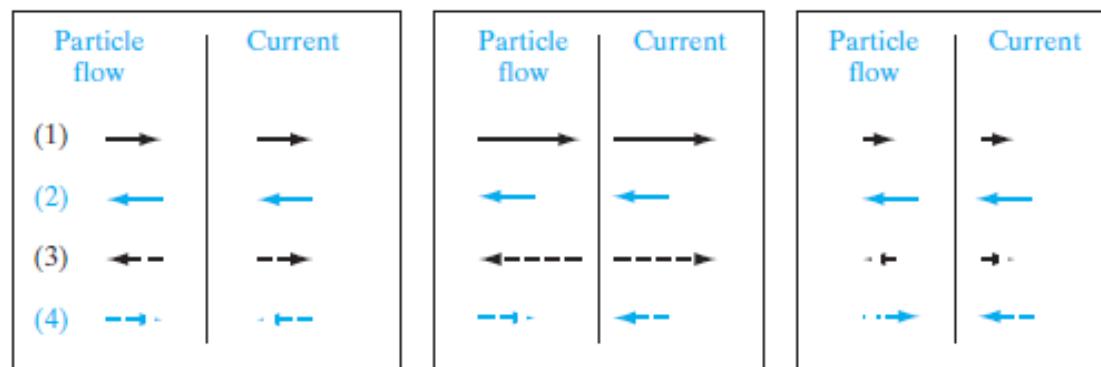
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Forward bias



$$I_D = I_s(e^{V_D/nV_T} - 1)$$



(1) Hole diffusion
(2) Hole drift

(3) Electron diffusion
(4) Electron drift

n – ideality factor of diode

Thank you