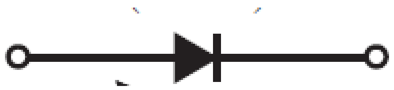
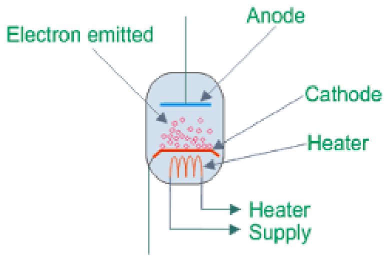
Fundamentals of Electronics

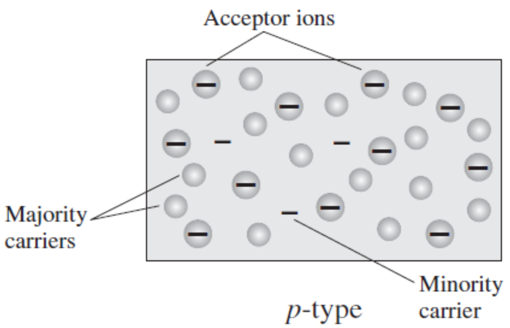
ECE 101

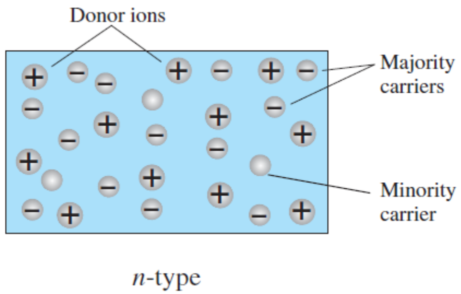
Diode: semiconductor junction

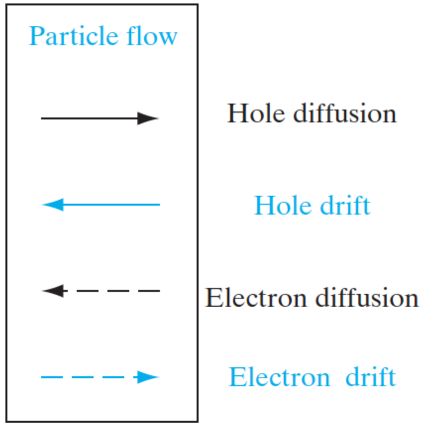


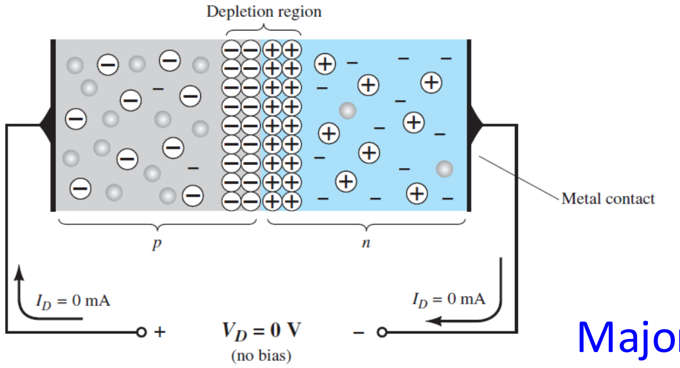


- Once we have both n-type and p-type materials available with us, what happens when we put two different kind of materials together.









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.

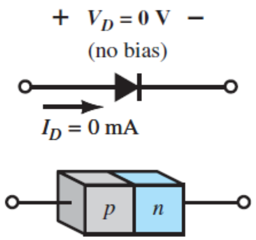
Equilibrium and steady state

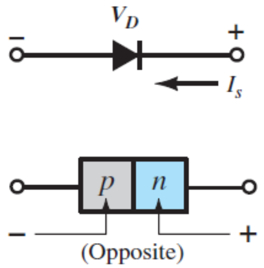
PN junction: under bias

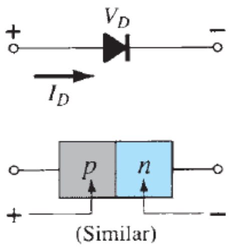
Reverse bias

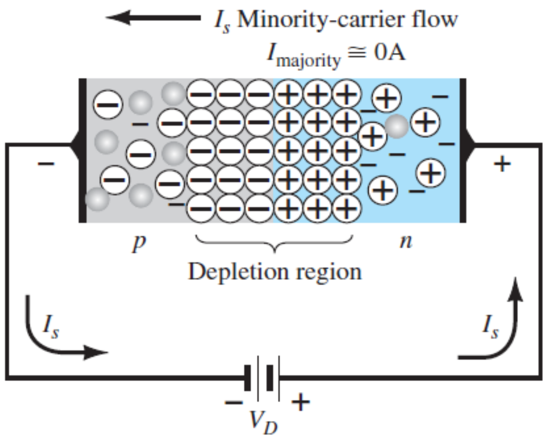
Forward bias

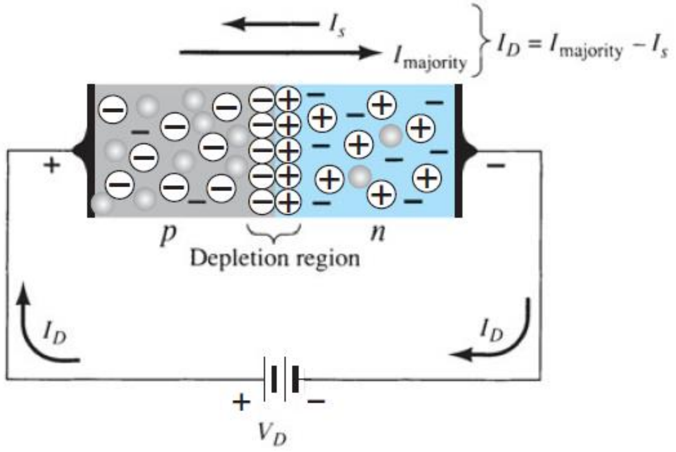
No bias

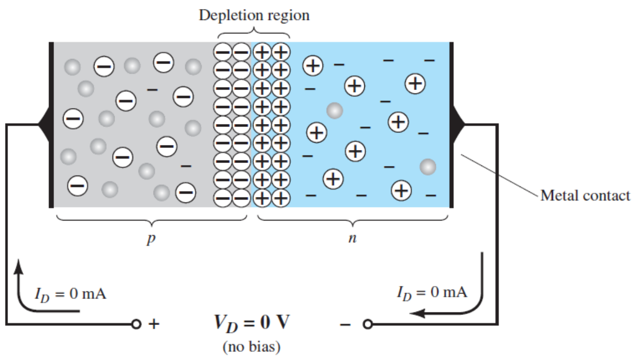












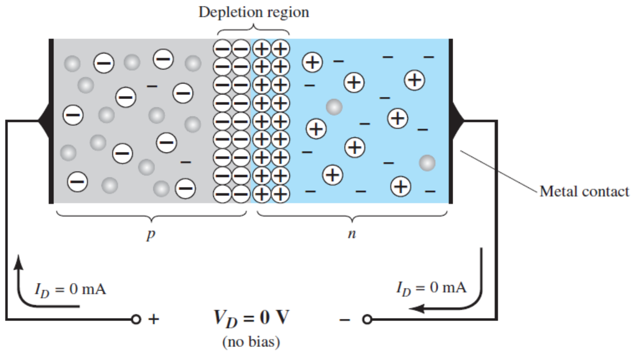
$$I_D = I_s(e^{V_D/nV_T} - 1)$$

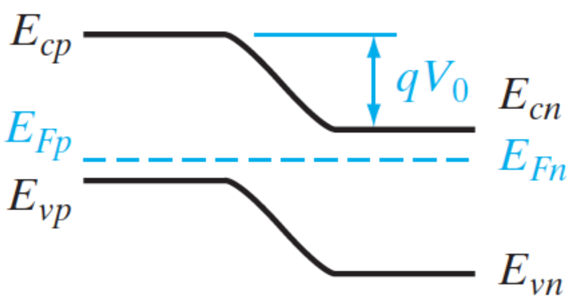
Depletion region

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

n – ideality factor of diode

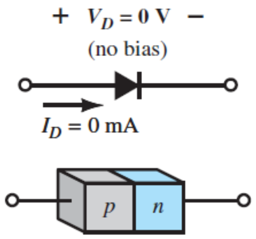
PN junction: diode





Depletion region

Equilibrium conditions



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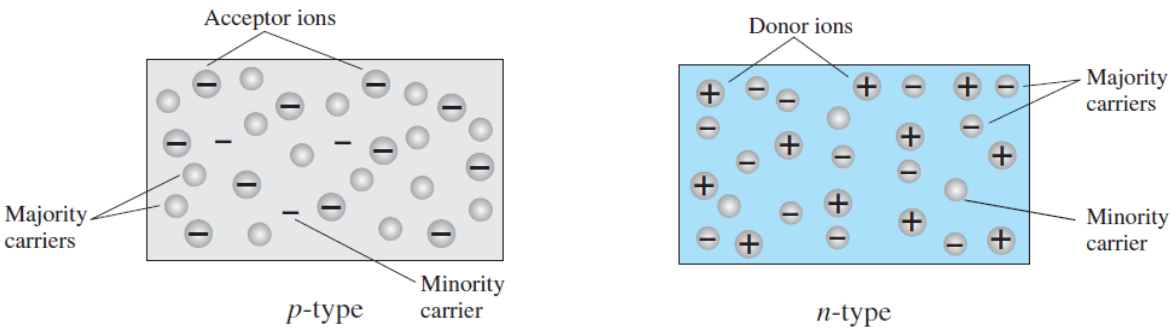
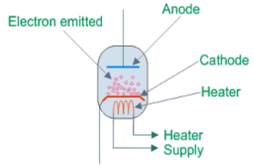
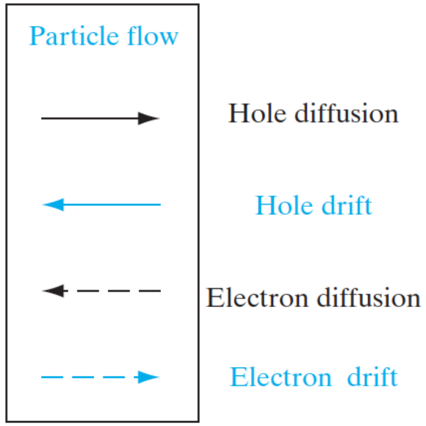
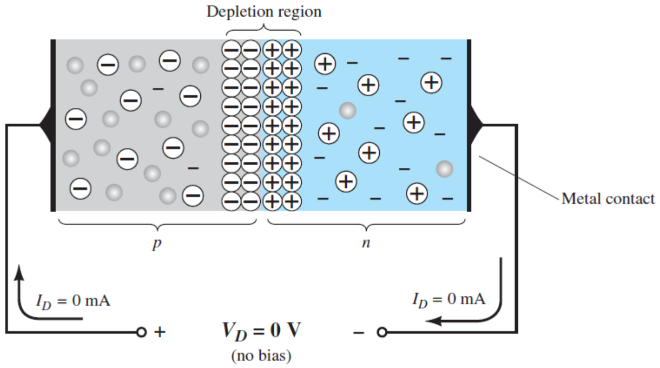
Summary









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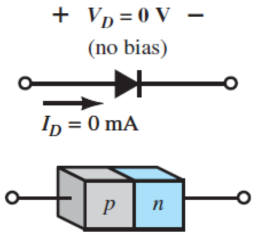

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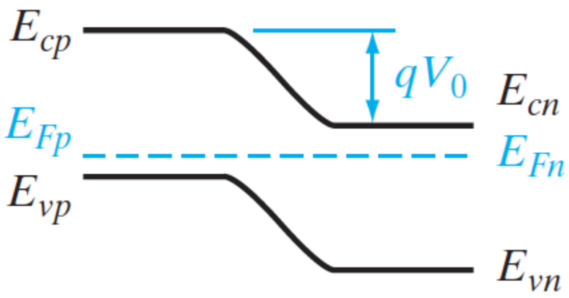

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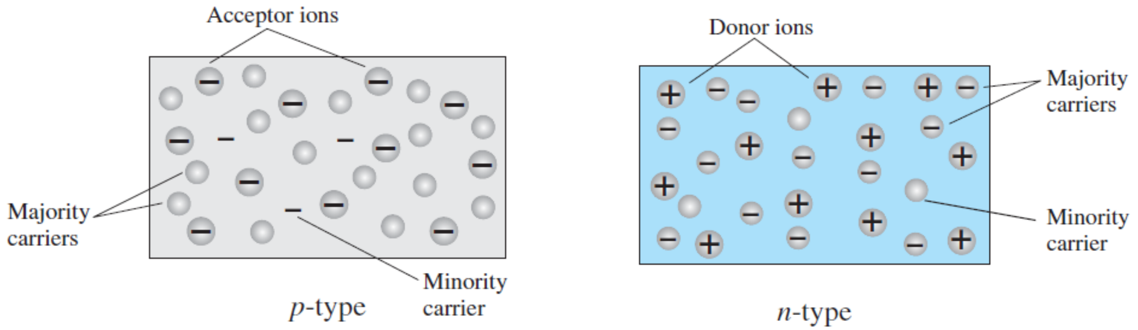

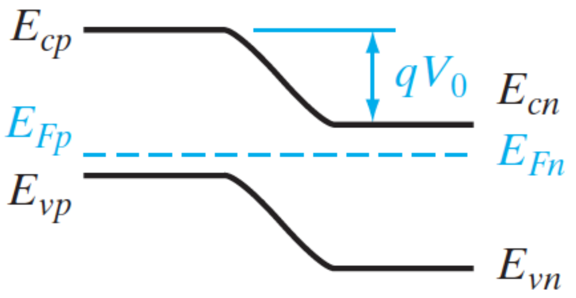

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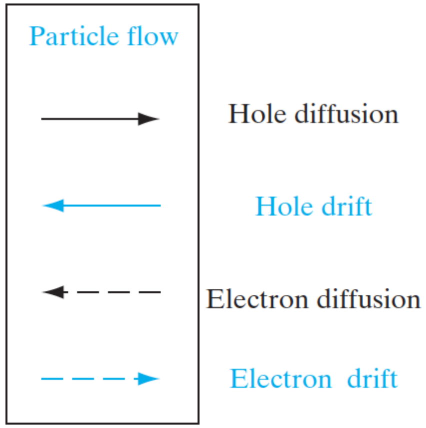
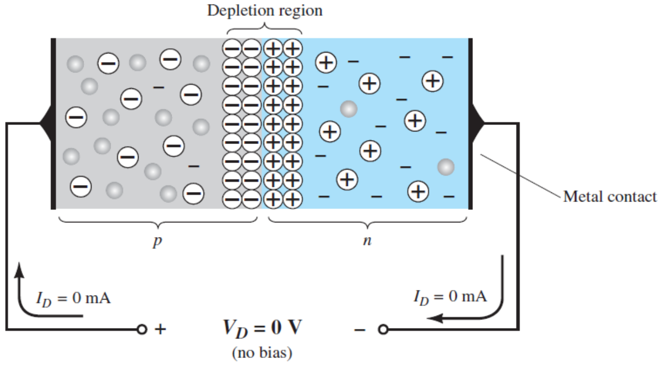
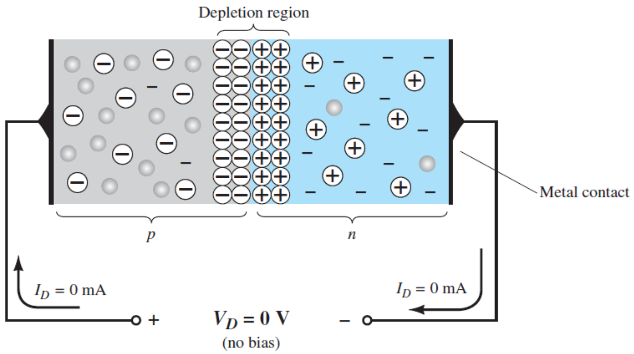
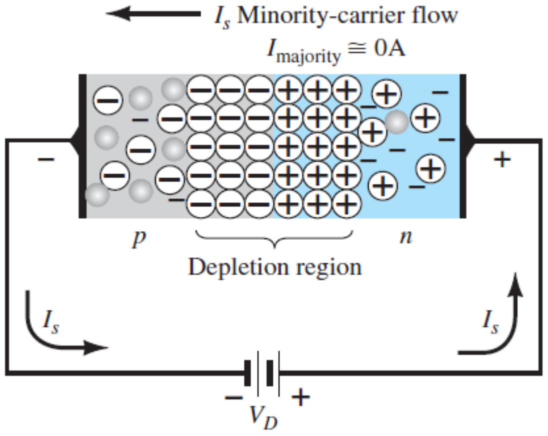


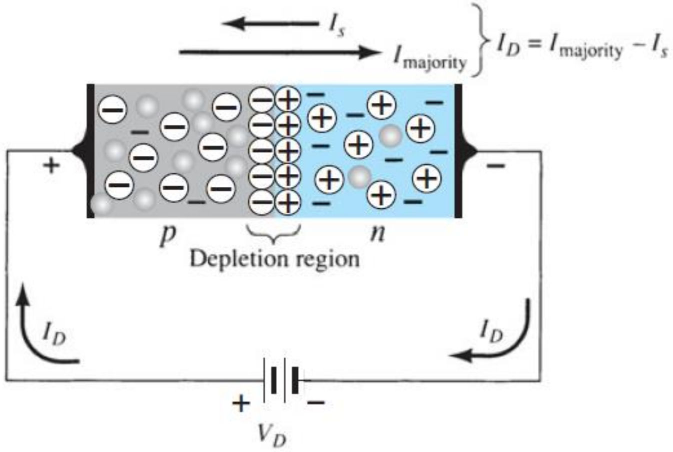




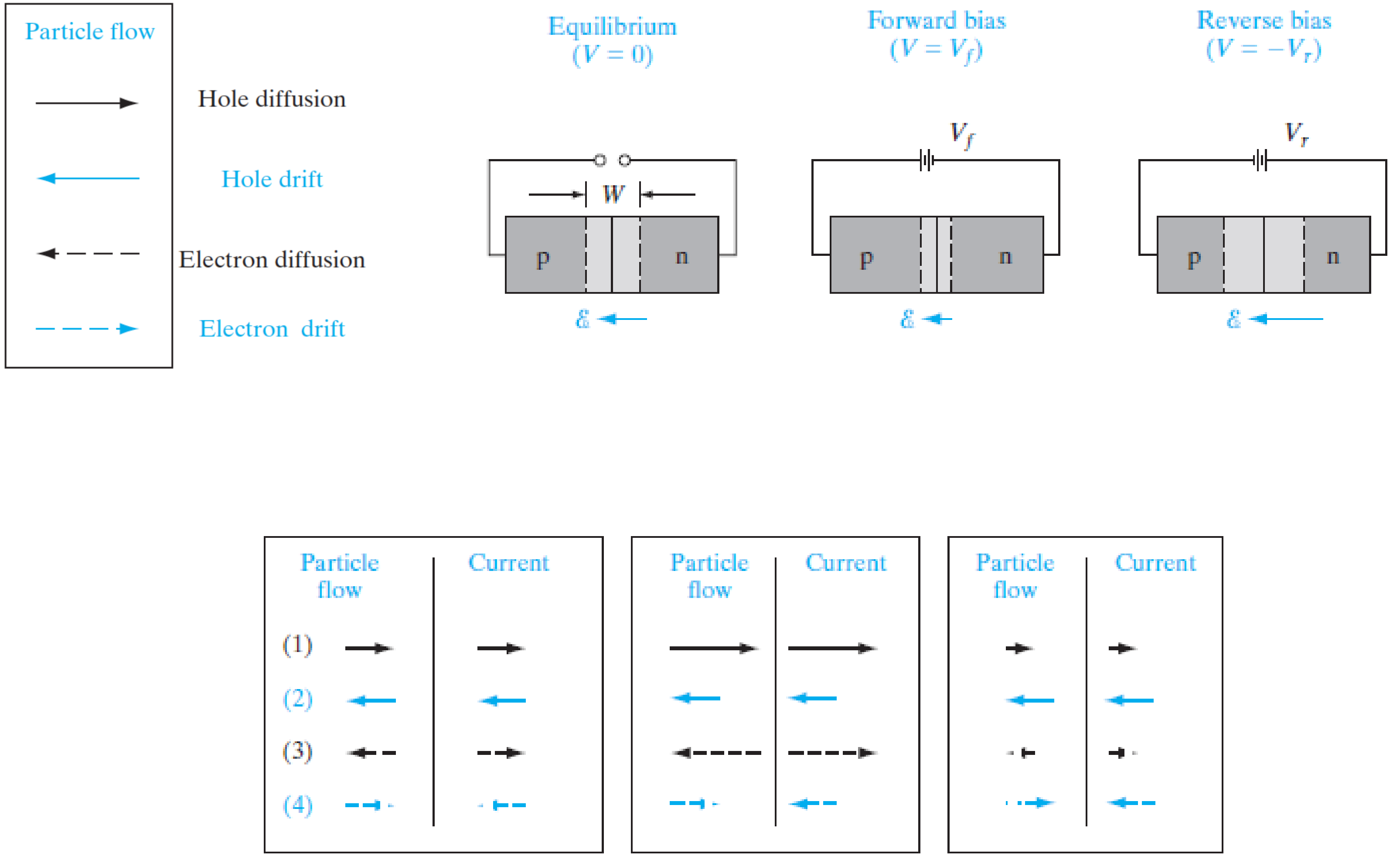
No bias



Reverse bias



Forward bias



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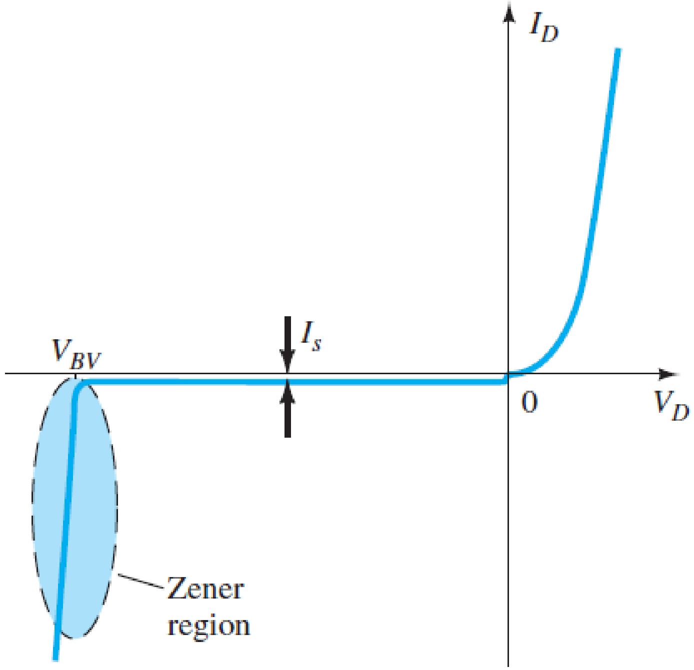
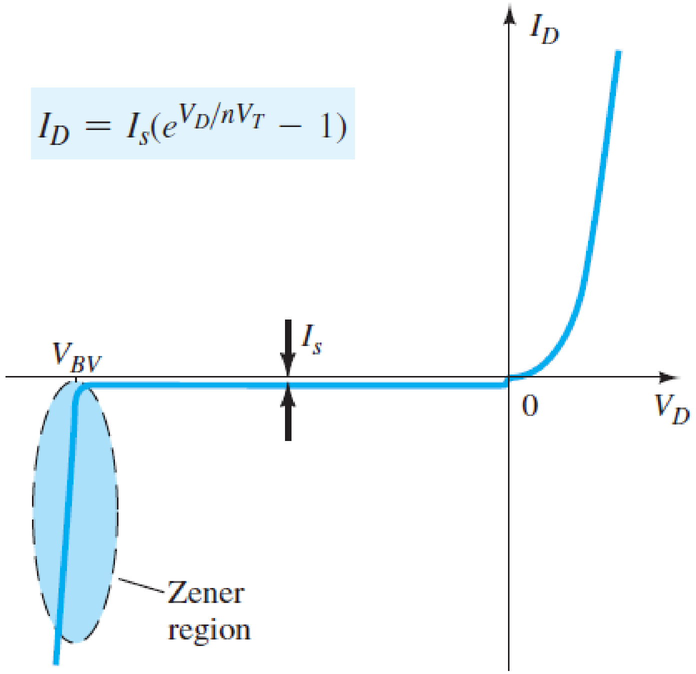


$$I_D = I_s(e^{V_D/nV_T} - 1)$$

n – ideality factor of diode

Diode IV characteristics and breakdown



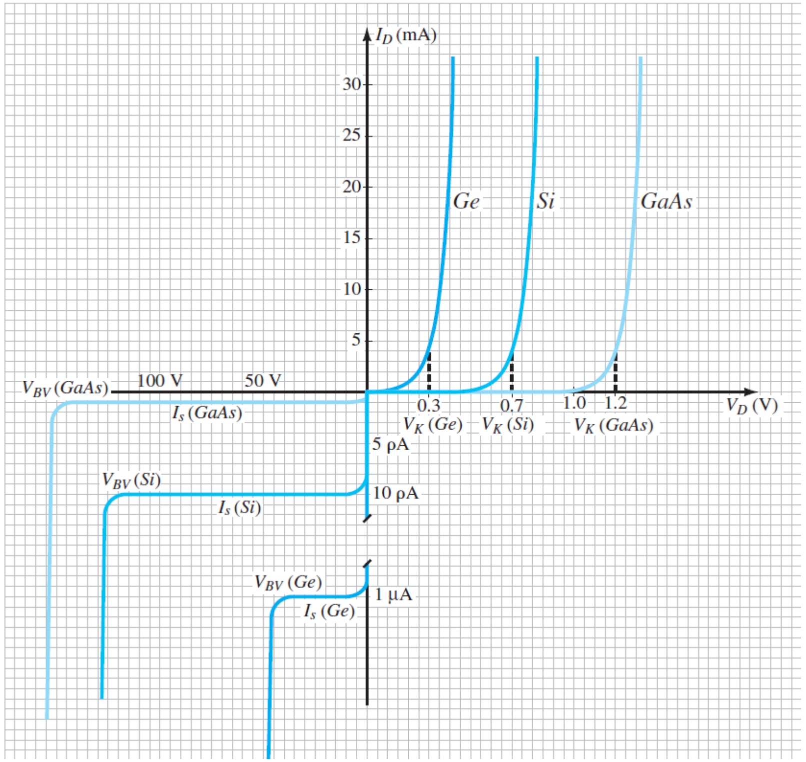
- As the voltage across the diode increases in the reverse-bias region, the velocity of the minority carriers responsible for the reverse saturation current (I_s) will also increase.
- Eventually, their velocity and associated kinetic energy will be sufficient to release additional carriers through collisions with otherwise stable atomic structures.

Diode: different semiconductors

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}

In presence of light?

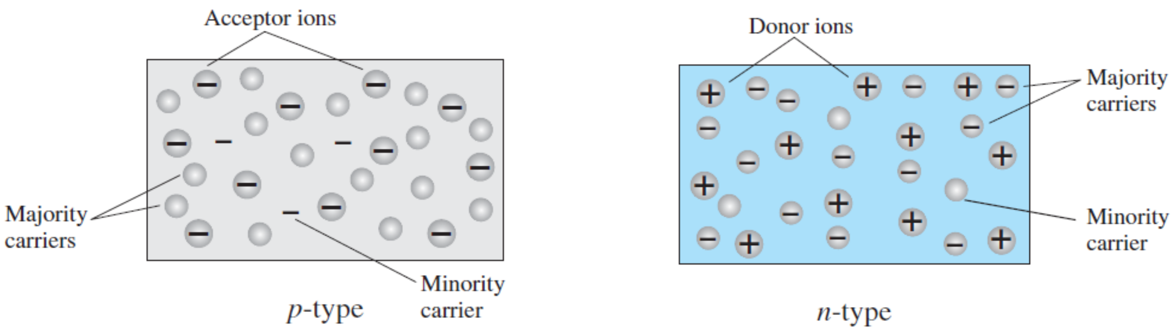


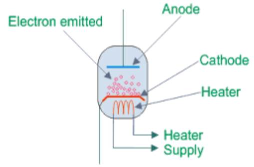
Si = 1.1 eV

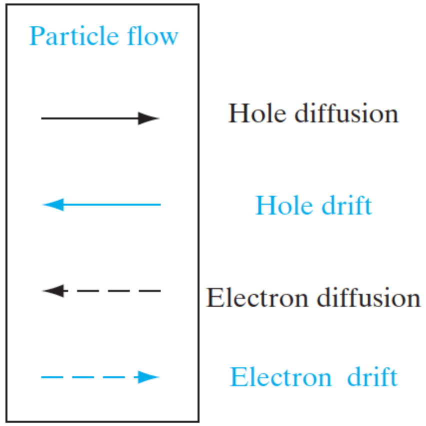
Ge = 0.67 eV

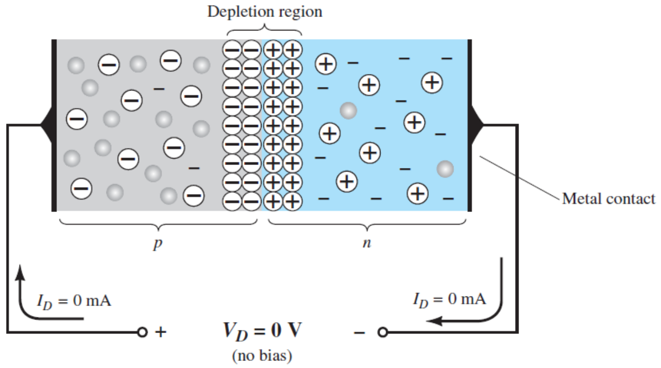
GaAs = 1.42 eV

Summary









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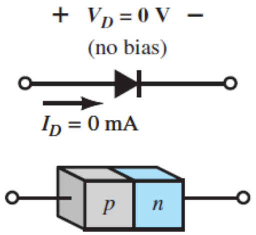

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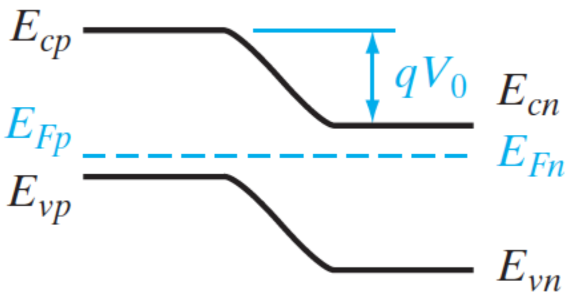

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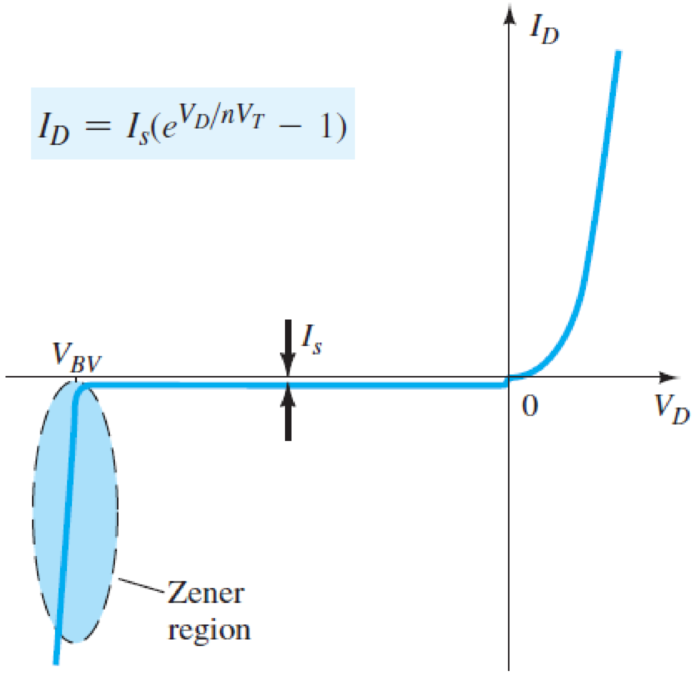

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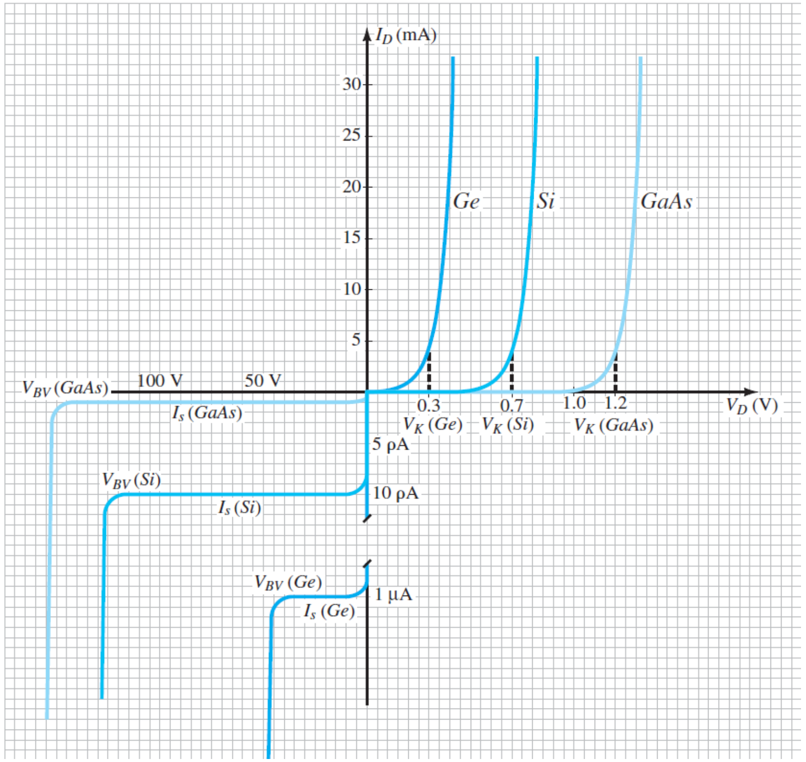

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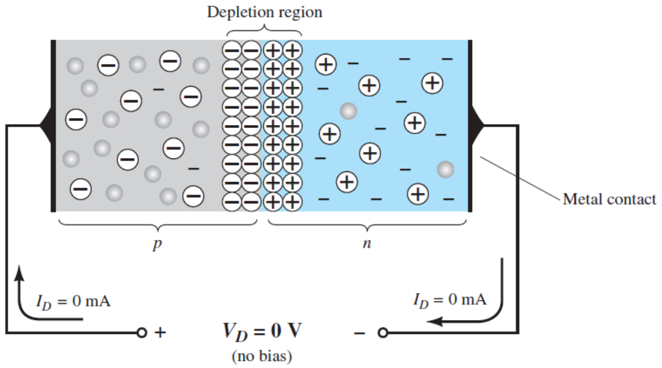
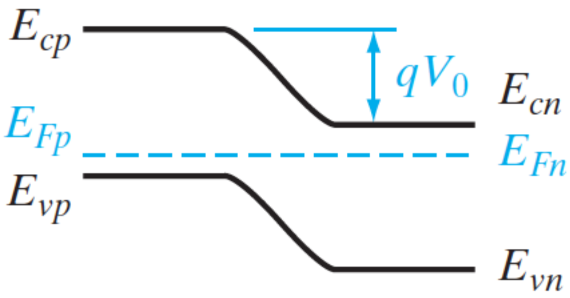
Review





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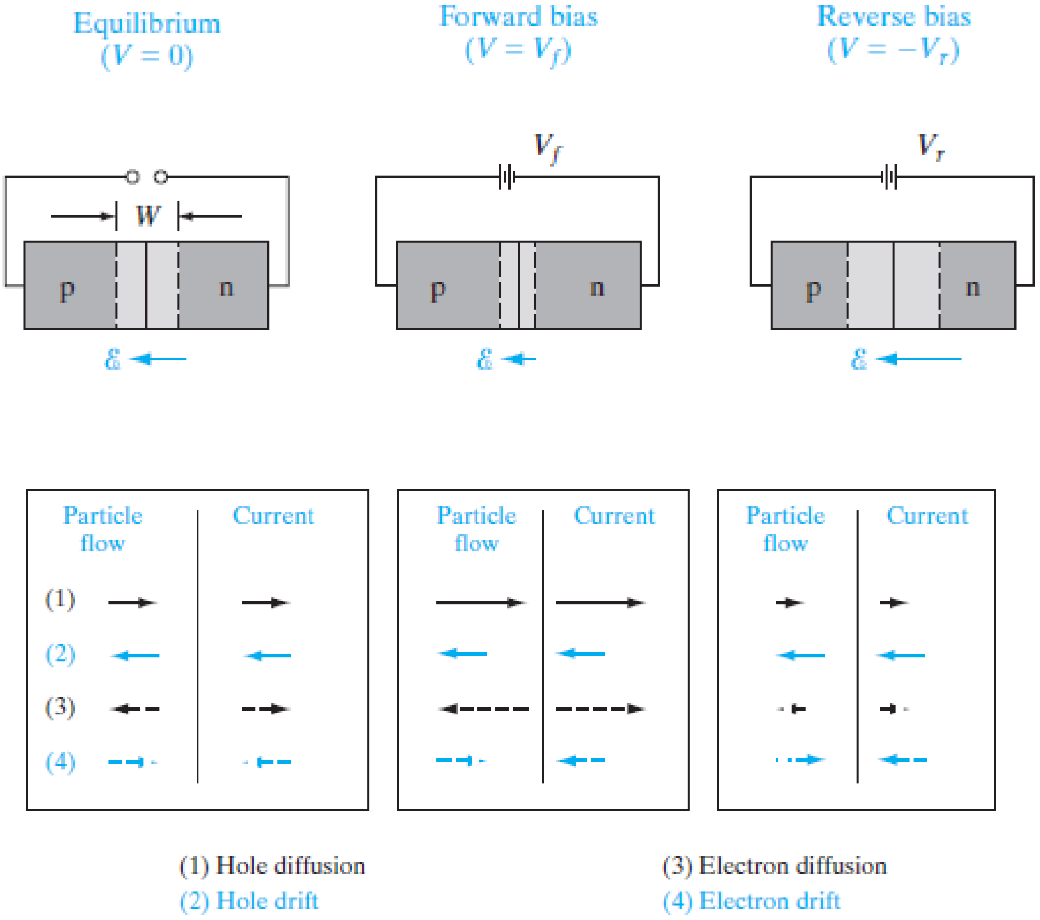

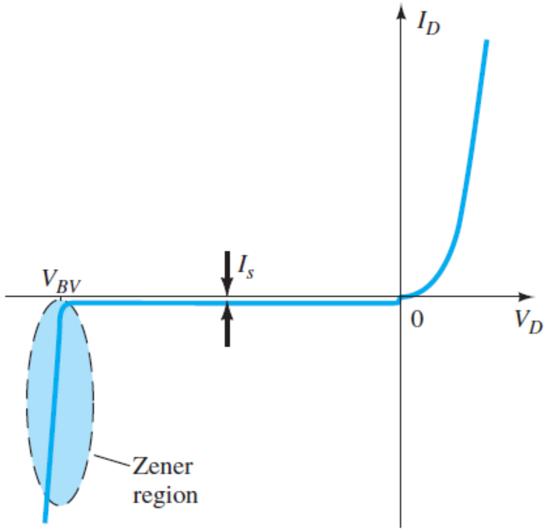

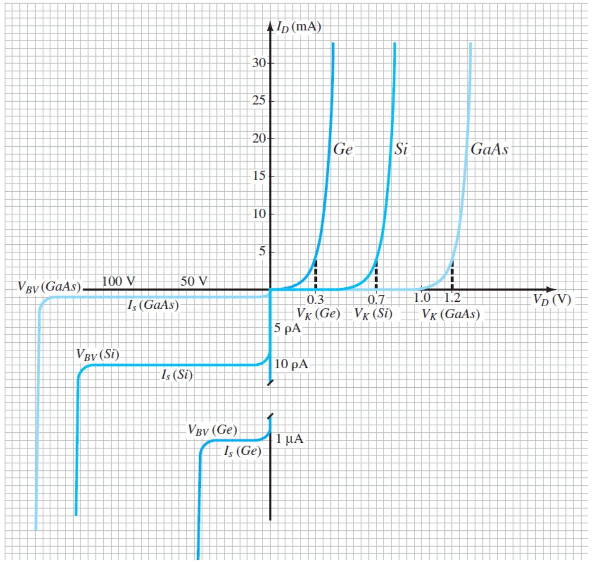

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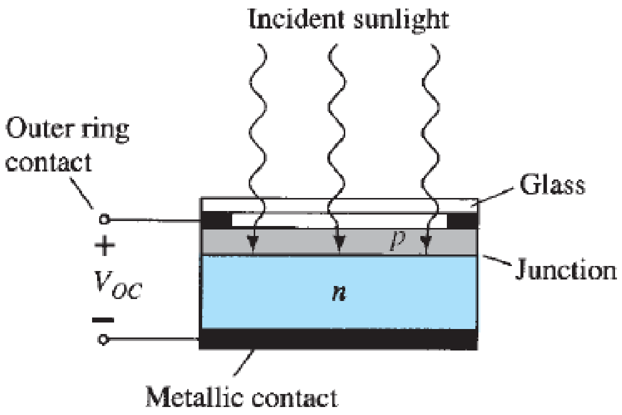
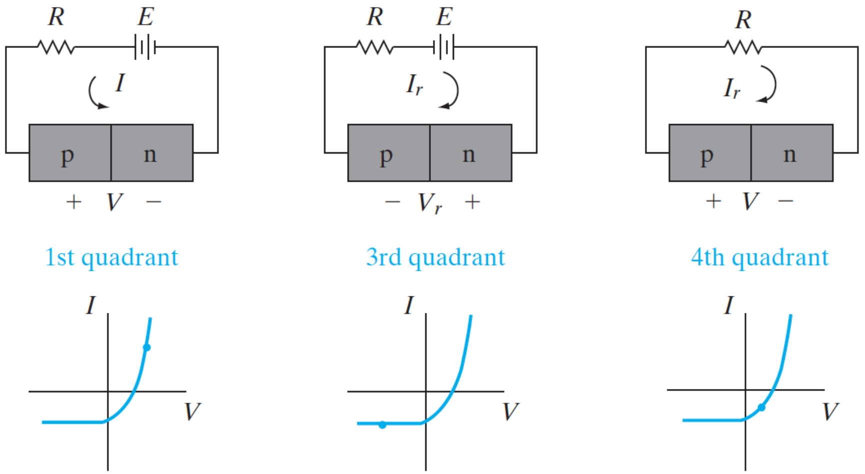
Diode applications

Solar Cells





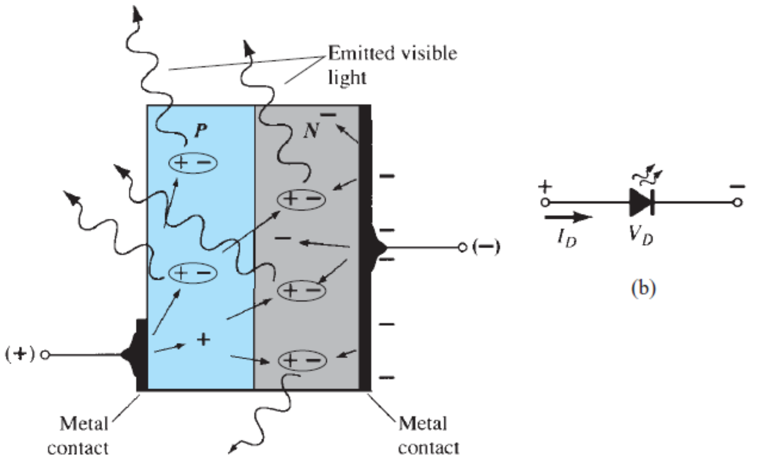
Open circuit voltage

Short circuit current

LEDs

- In Si and Ge diodes the greater percentage of the energy converted during recombination at the junction is dissipated in the form of heat within the structure, and the emitted light is insignificant.

- Diodes constructed of GaAs emit light in the infrared (invisible) zone during the recombination process at the p–n junction.



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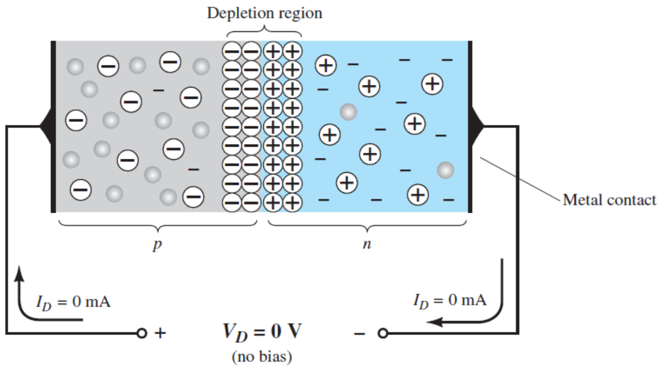

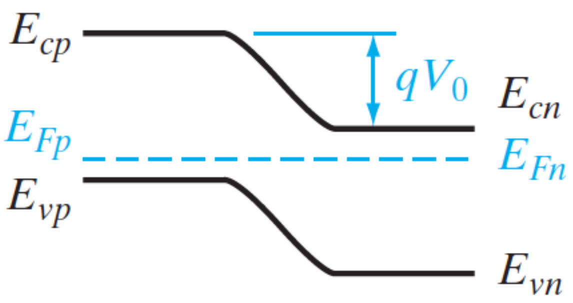

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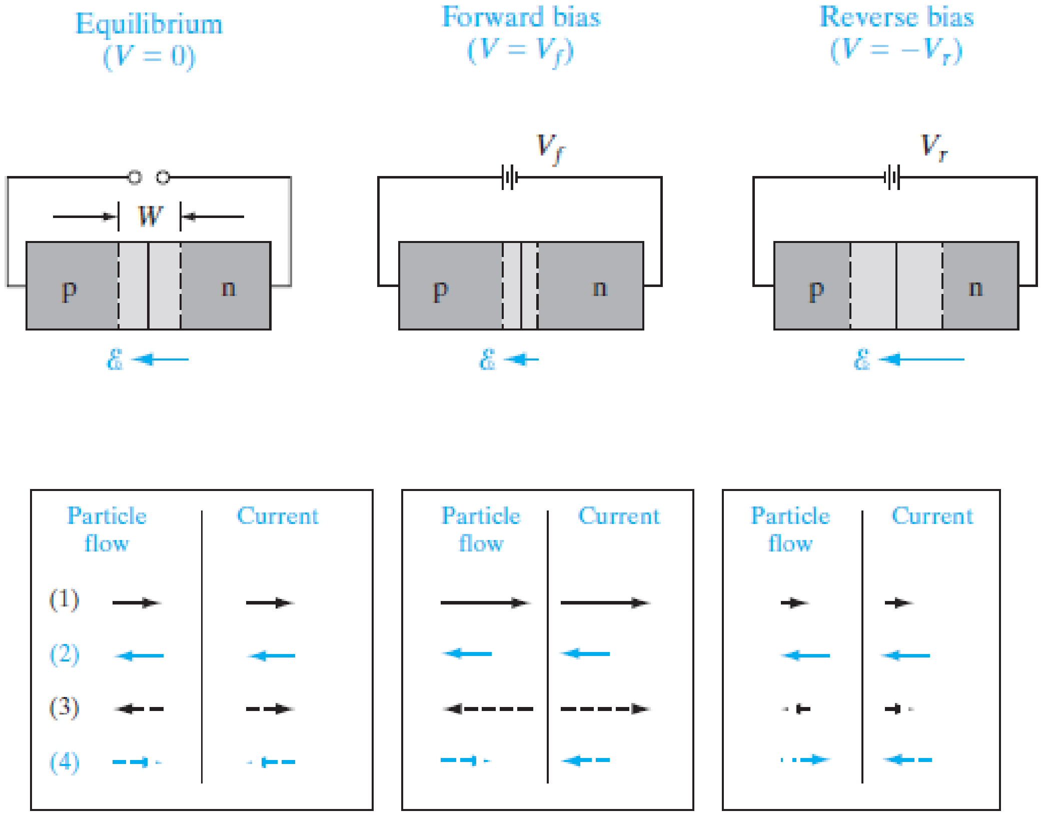

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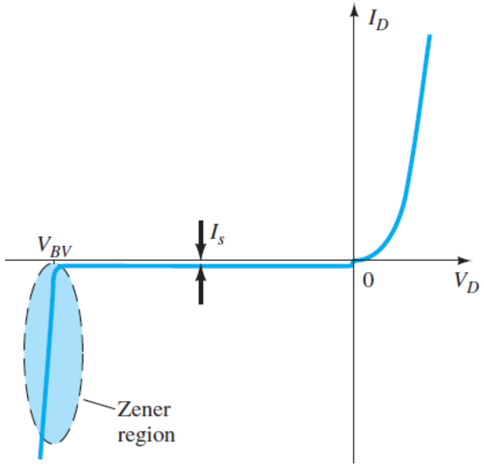

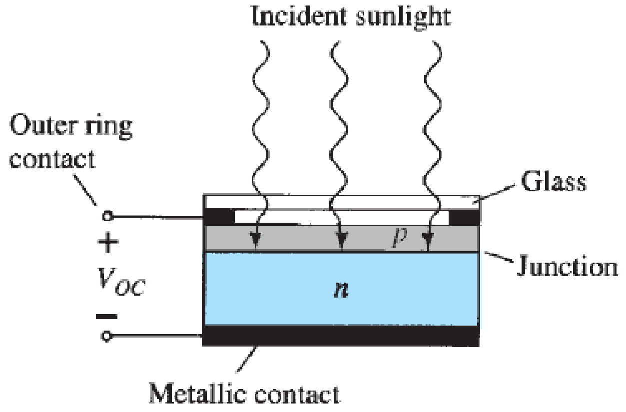

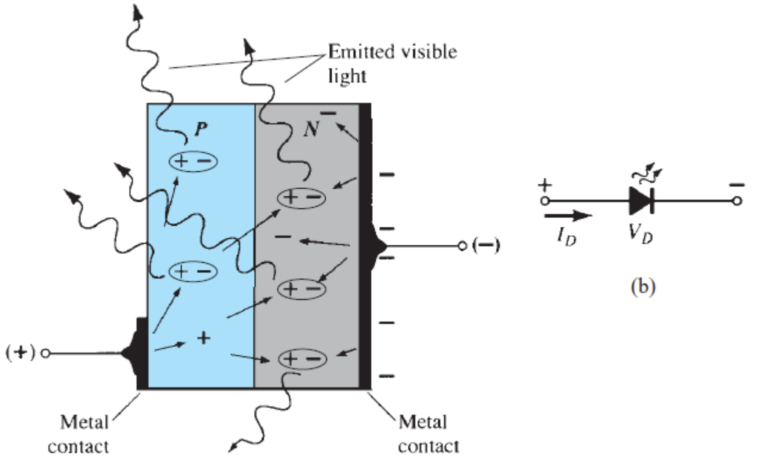

Thank you