



BENHA UNIVERSITY
FACULTY OF ENGINEERING AT SHOUBRA

ELC301
Electronic Engineering

Lecture #3
Special Diodes

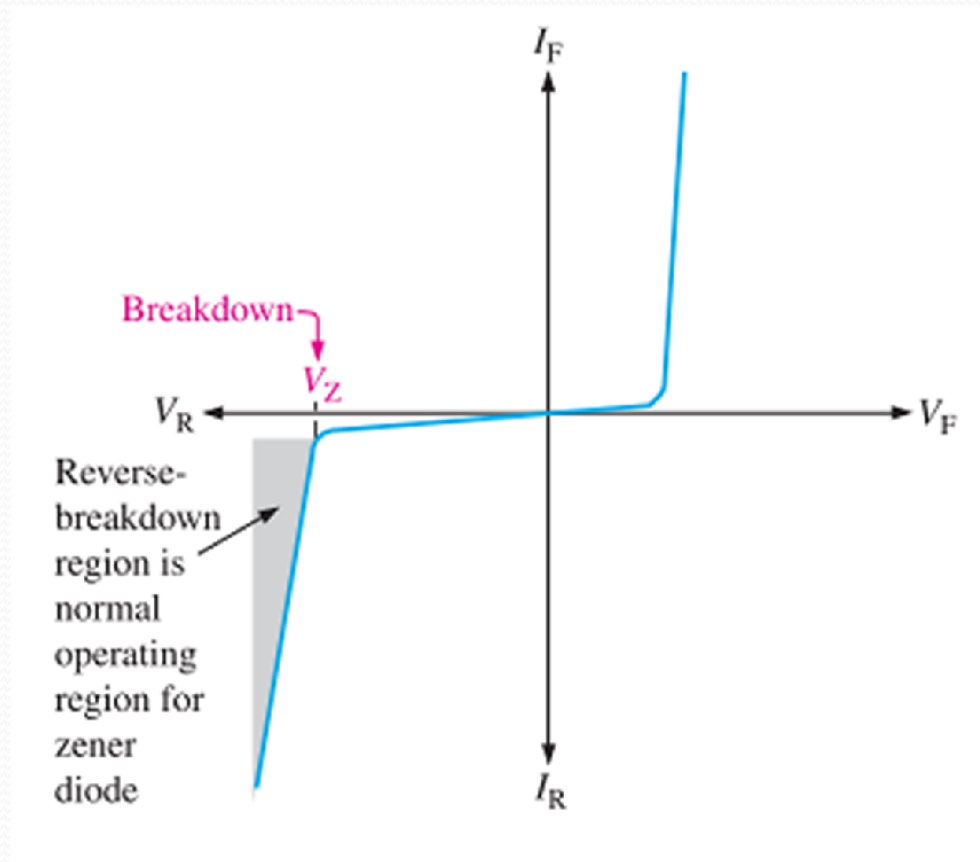
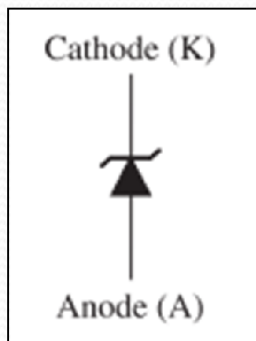
Instructor:

Dr. Moataz Elsherbini

Special Purpose Diodes

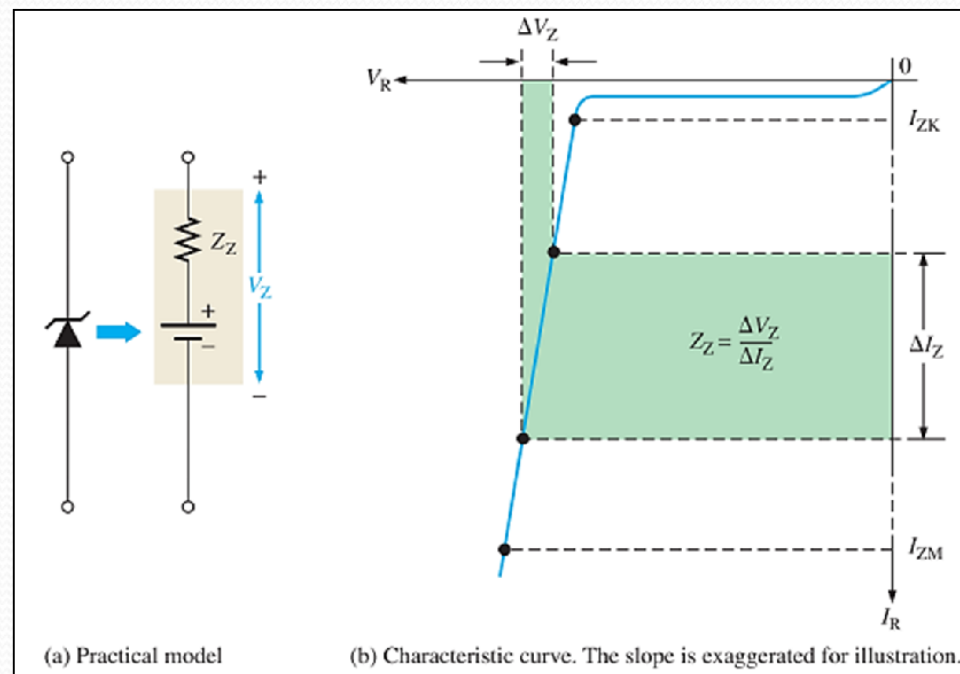
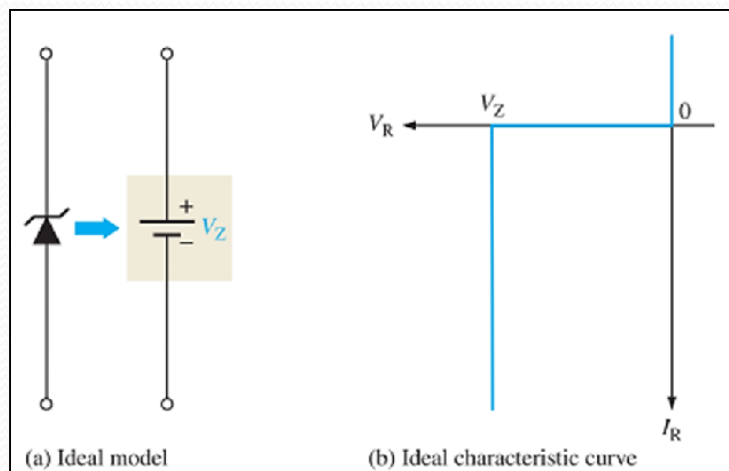
The Zener Diode

- A zener diode is a silicon pn junction device that is designed for operation in the reverse-breakdown region.
- The breakdown voltage of a zener diode is set by carefully controlling the doping level during manufacture.

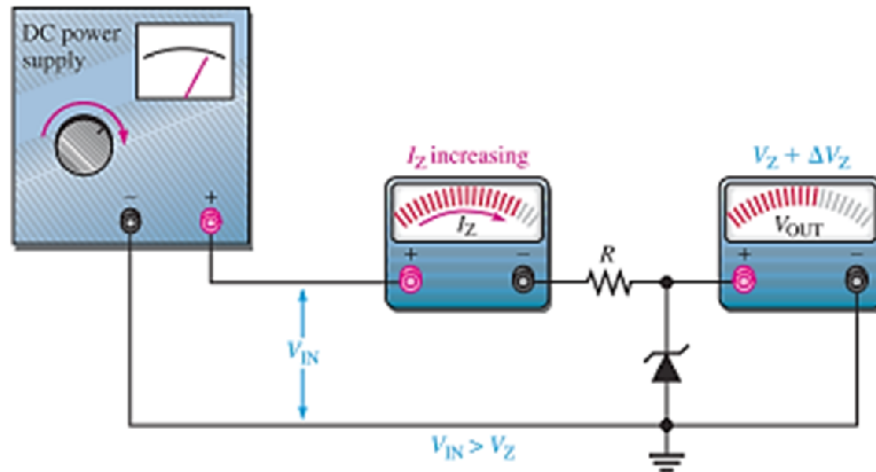


Zener Equivalent Circuits

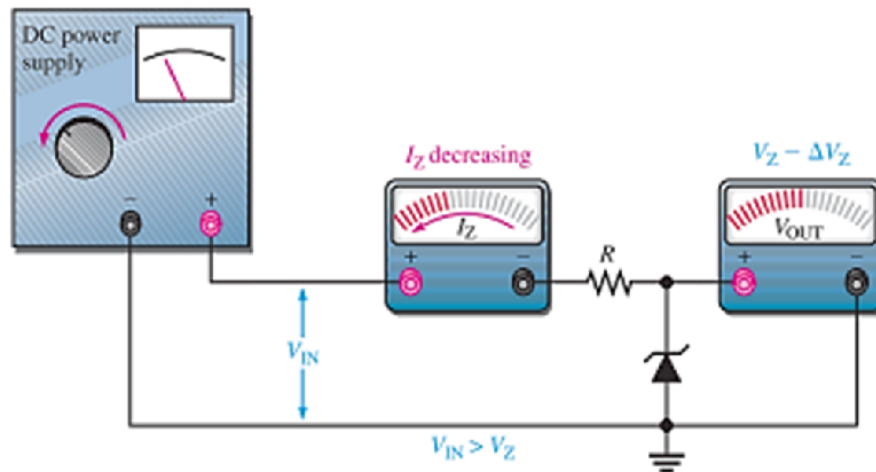
- Zener is used as Regulator
- Two Models
 - Ideal Model
 - Practical Model



Zener regulation



(a) As the input voltage increases, the output voltage remains nearly constant ($I_{ZK} < I_Z < I_{ZM}$).



(b) As the input voltage decreases, the output voltage remains nearly constant ($I_{ZK} < I_Z < I_{ZM}$).

◀ FIGURE 3-9

Zener regulation of a varying input voltage.

Zener Regulation

- Zener Regulation with a Variable Input Voltage

$$I_{ZK} = 0.25\text{mA}, P_{D(\text{max})} = 1\text{W}, V_Z = 10\text{V}$$

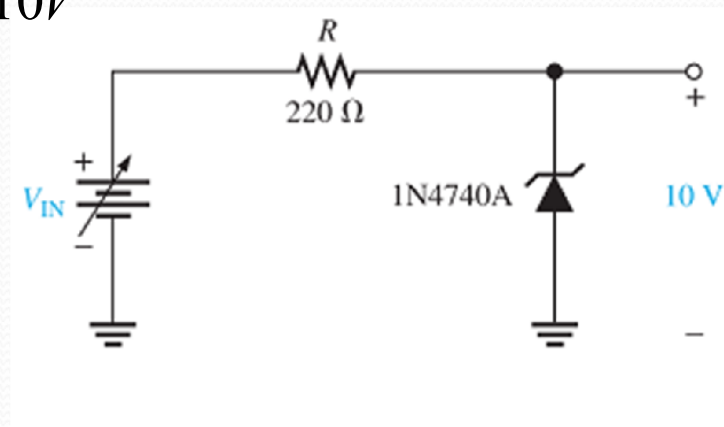
$$I_{ZM} = \frac{P_{D(\text{max})}}{V_Z} = \frac{1\text{W}}{10\text{V}} = 100\text{mA}$$

$$V_R = I_{ZK}R = (0.25\text{mA})(220\ \Omega) = 55\text{mV}$$

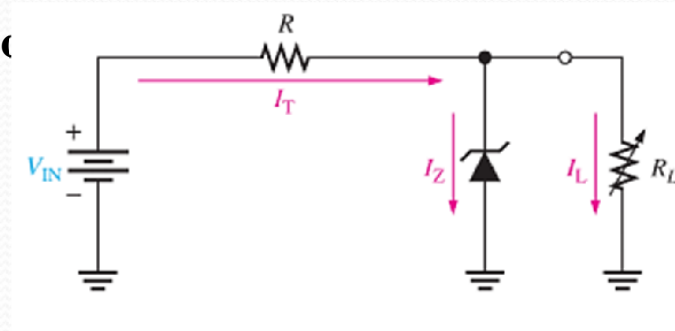
$$V_{\text{IN}(\text{min})} = V_R + V_Z = 55\text{mV} + 10\text{V} = 10.055\text{V}$$

$$V_R = I_{ZM}R = (100\text{mA})(220\ \Omega) = 22\text{V}$$

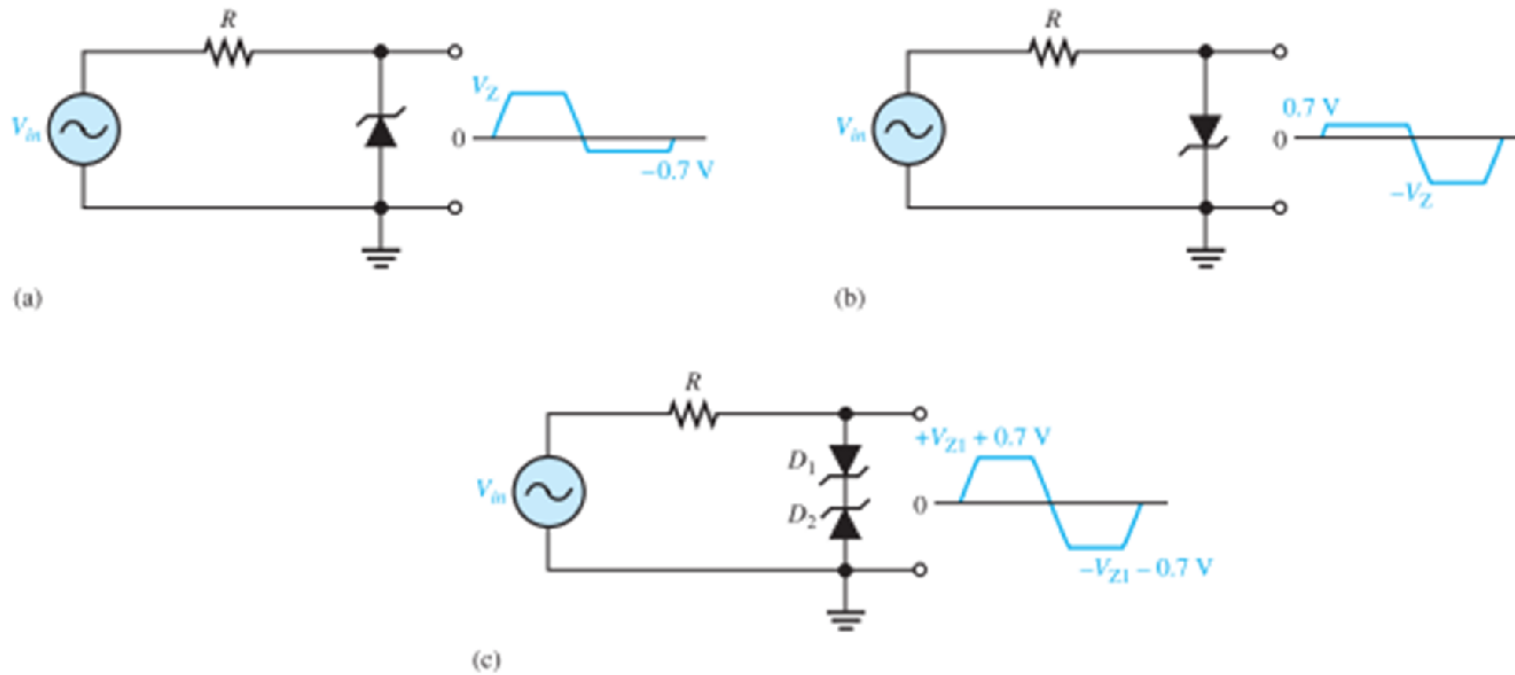
$$V_{\text{IN}(\text{max})} = 22\text{V} + 10\text{V} = 32\text{V}$$



- Zener Regulation with a Variable Load



Zener Limiter



▲ FIGURE 3-18

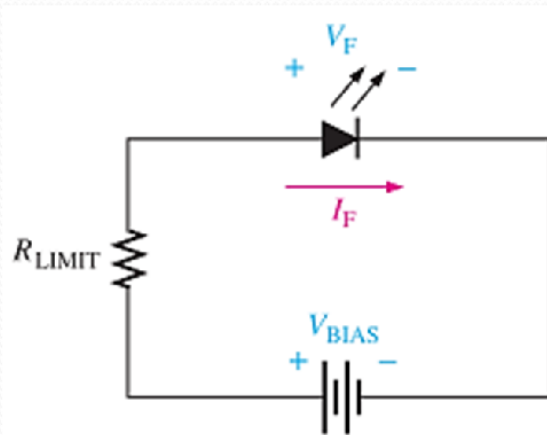
Basic zener limiting action with a sinusoidal input voltage.

Optical Diodes

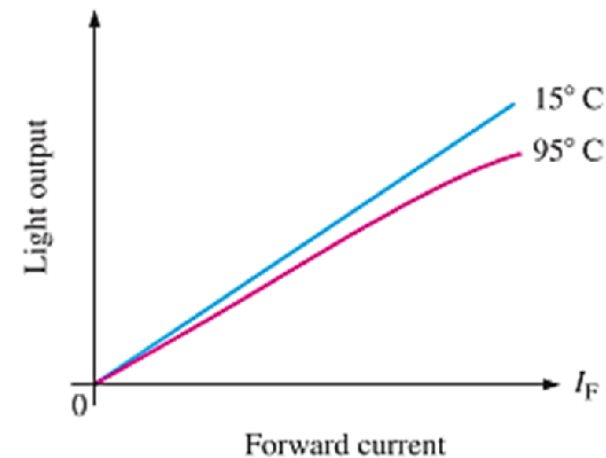
The Light-Emitting Diode (LED)

Basic operation :

- When the device is forward-biased, electrons cross the pn junction from the n-type material and recombine with holes in the p-type material.
- The difference in energy between the electrons and the holes corresponds to the energy of visible light.
- When recombination takes place, the recombining electrons release energy in the form of *photons*.

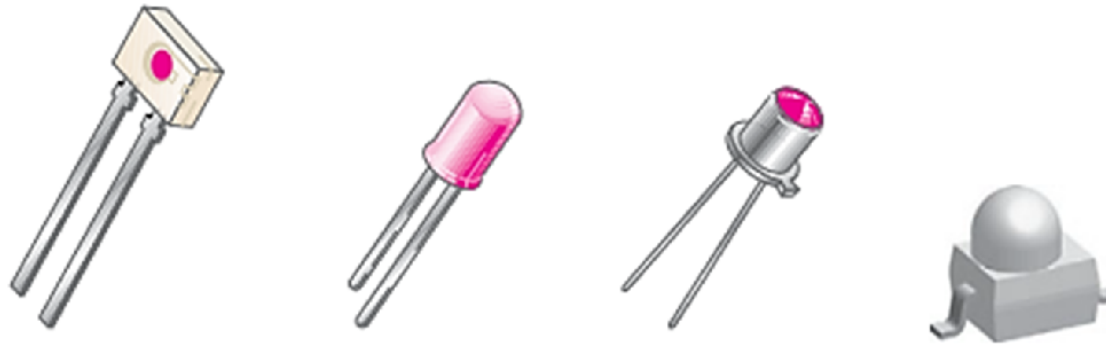


(a) Forward-biased operation

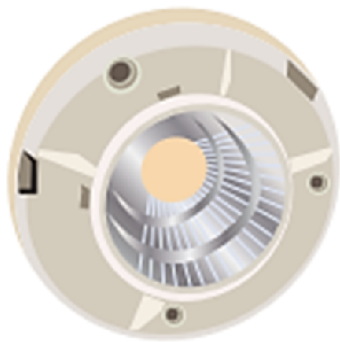


(b) General light output versus forward current for two temperatures

Typical LEDs



(a) Typical small LEDs for indicators



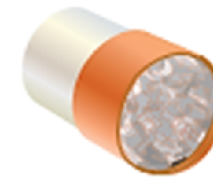
Helion 12 V overhead light with socket and module



120 V, 3.5 W screw base for low-level illumination



120 V, 1 W small screw base candelabra style

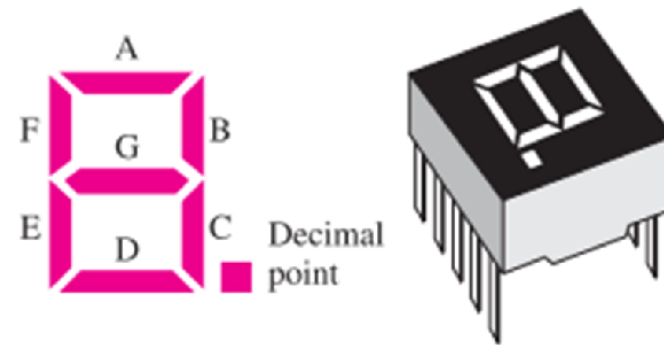


6 V, bayonet base for flashlights, etc.

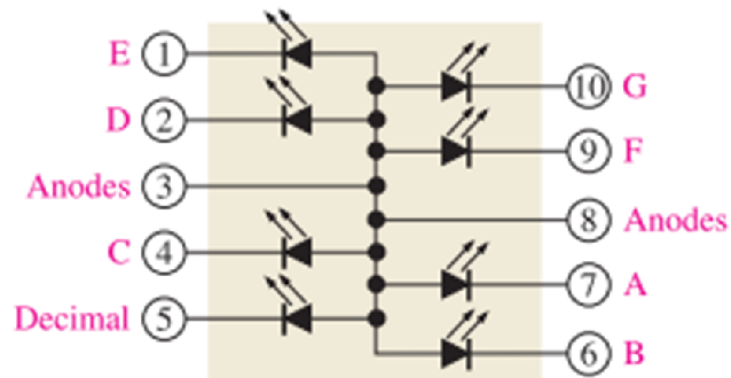
(b) Typical LEDs for lighting applications

LED Application

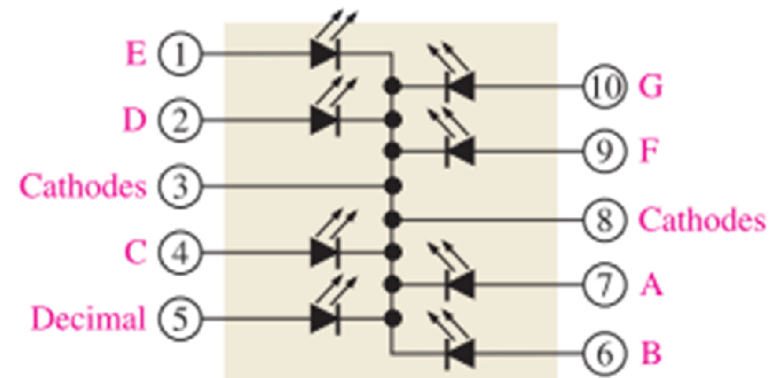
7-Segment Display



(a) LED segment arrangement and typical device



(b) Common anode

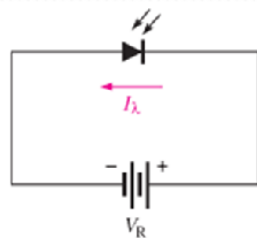


(c) Common cathode

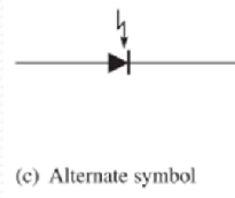
Optical Diodes

The Photodiode

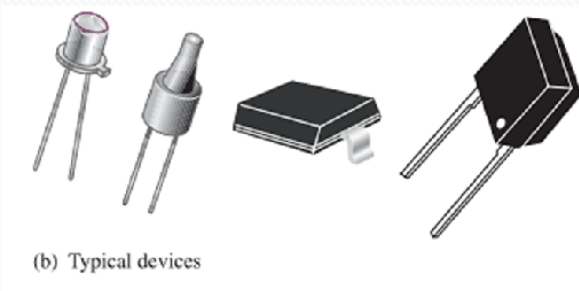
- The photodiode is a device that operates in reverse bias where I_{λ} is the reverse light current.
- The photodiode has a small transparent window that allows light to strike the pn junction.
- Internal Resistance changes by the amount of light.



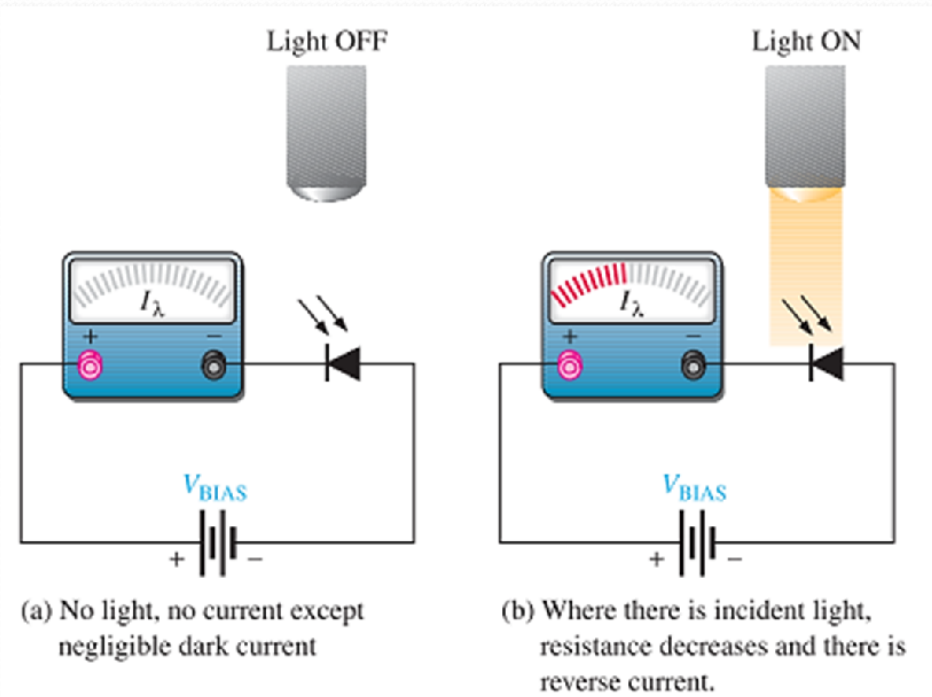
(a) Reverse-bias operation using standard symbol



(c) Alternate symbol

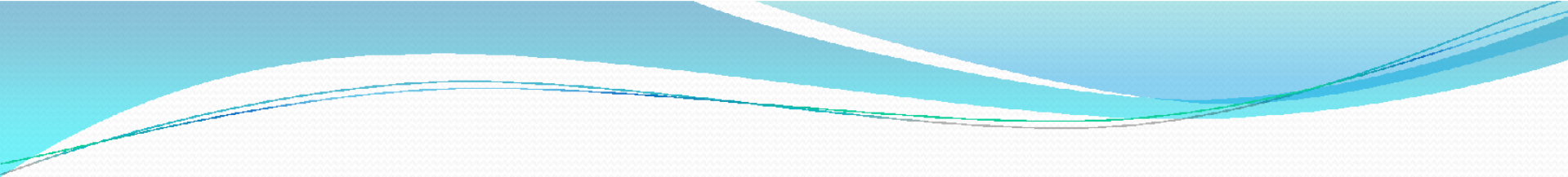


(b) Typical devices



(a) No light, no current except negligible dark current

(b) Where there is incident light, resistance decreases and there is reverse current.

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- For more details, refer to:
 - Chapter 2,3, T. Floyd, **Electronic Devices and Circuit Theory**, 11th edition, Prentice Hall.
 - The lecture is available online at:
 - <http://bu.edu.eg/staff/motazaliz-courses/14630>
 - For inquires, send to:
 - Motaz.ali@feng.bu.edu.eg