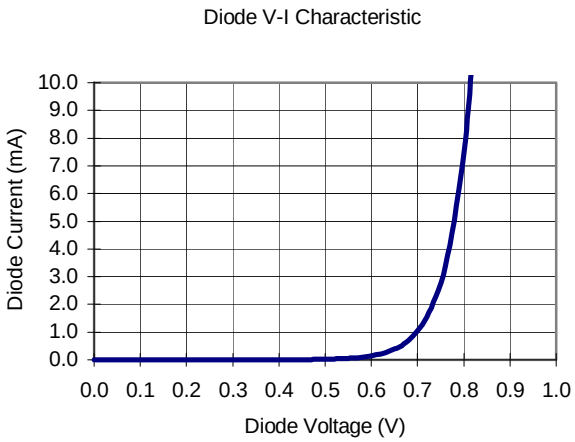
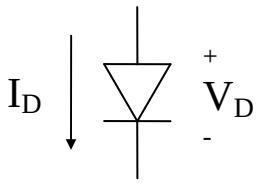
THE DIODE EQUATION





William Shockley's Diode Equation

$$I_D = I_S\,(e^{V_D / nV_T} - 1)$$

I_S = Saturation Current (Constant 10^{-9} to 10^{-15} A)
- Increases greatly with temperature (as a function of T^3).
- Directly proportional to cross-sectional area of diode.

n = Constant (Between 1 and 2)

V_T = Thermal Voltage = kT/q ≈ 25mV @ 20°C
≈ 26mV @ 25°C

k = Boltzmann's Constant (1.38×10^{-23} J / K)
T = Absolute Temperature (K)
q = Charge of an Electron (1.6×10^{-19} C)

Approximate Form

$$I_D \approx I_S\, e^{V_D / nV_T}$$

Less than 1% error for $V_D > 230$ mV (for n=2, $V_T = 25$mV)

Useful Forms

Current Ratio: $I_2 / I_1 = e^{(V_2 - V_1) \,/\, nV_T}$

Voltage Difference: $\Delta V = (V_2 - V_1) = nV_T \,\mathrm{Ln}\,(I_2 / I_1)$
$\approx 0.1\,\mathrm{LOG}_{10}\,(I_2 / I_1)$

i.e. A factor of 10 change in current for every 0.1 V change in V_D.