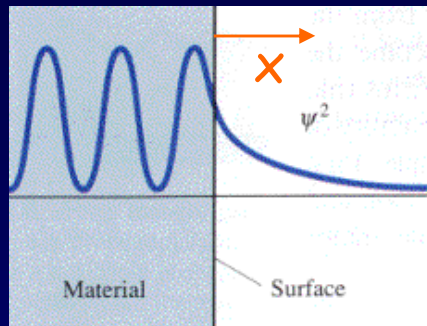
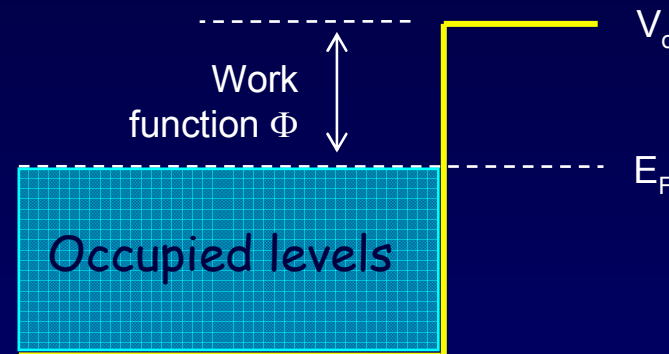


"Leaky" Particles

Due to "barrier penetration", the electron density of a metal actually extends outside the surface of the metal!



$x = 0$



Assume that the work function (i.e., the energy difference between the most energetic conduction electrons and the potential barrier at the surface) of a certain metal is $\Phi = 5 \text{ eV}$. Estimate the distance x outside the surface of the metal at which the electron probability density drops to 1/1000 of that just inside the metal.

$$\frac{|\psi(x)|^2}{|\psi(0)|^2} = e^{-2Kx} \approx \frac{1}{1000} \quad \longrightarrow \quad x = -\frac{1}{2K} \ln\left(\frac{1}{1000}\right) \approx 0.3 \text{ nm}$$

$$K = \sqrt{\frac{2m_e}{\hbar^2}(V_0 - E)} = 2\pi \sqrt{\frac{2m_e}{h^2} \Phi} = 2\pi \sqrt{\frac{5 \text{ eV}}{1.505 \text{ eV} \cdot \text{nm}^2}} = 11.5 \text{ nm}^{-1}$$