

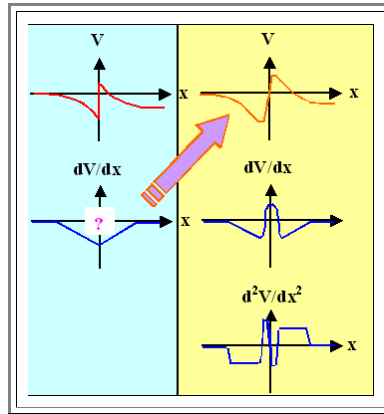
Potential Discontinuities and Dipole Layers

Basics

The [Poisson equation](#) in its simplest form reads

$$\epsilon_0 \epsilon_r \cdot \frac{d^2 V}{dx^2} = - \rho(x)$$

- Differentiating the potential V including possible discontinuities thus will give us the charge distribution $\rho(x)$. We can do that very easily in a qualitative way as shown on the left hand side below.



- Note that an infinitely sharp discontinuity will *not* be noticed in the dV/dx curves. The curves we get are identical to the [old curves](#) that did not contain a discontinuity.
- But *infinitely* sharp discontinuities, or singularities in general, mostly do not make sense in physics. All we have to do therefore, is to redraw the potential with the discontinuity spread over a small distance (obviously in the order of the atom size at the very minimum)
 - Differentiating graphically in a qualitative way now is easy, this is shown on the right hand side.
 - We now get a sharp "wiggles" in the charge distribution, corresponding to a *dipole layer* of charge right at the interface.
- Much can be learned from this. Here are a few suggestions for investigations of your own:
 - Look at the other type of discontinuity.
 - Look at the case of extremely heavily doped semiconductors
 - Now look at the junction between two different metals. Can you understand why such a junction is not "felt" electronically?
 - Can you guess on how much charge is transferred from one material to the other one? On the field strength that we encounter in these dipole layers?