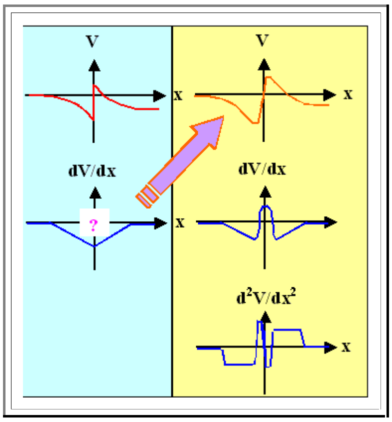
Potential Discontinuities and Dipole Layers

- 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 gives us the charge distribution **ρ(** ***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 **d*V*/d*x*** 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 "wiggle" 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?