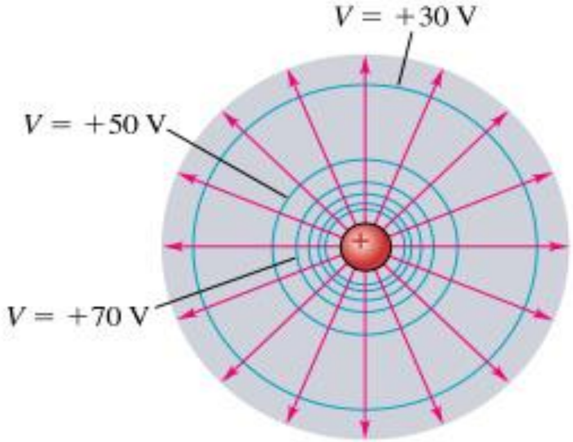
Last time

- Electric potential due to a dipole
- Electric field from electric potential for a dipole
- Electric potential of a solid spherical conductor

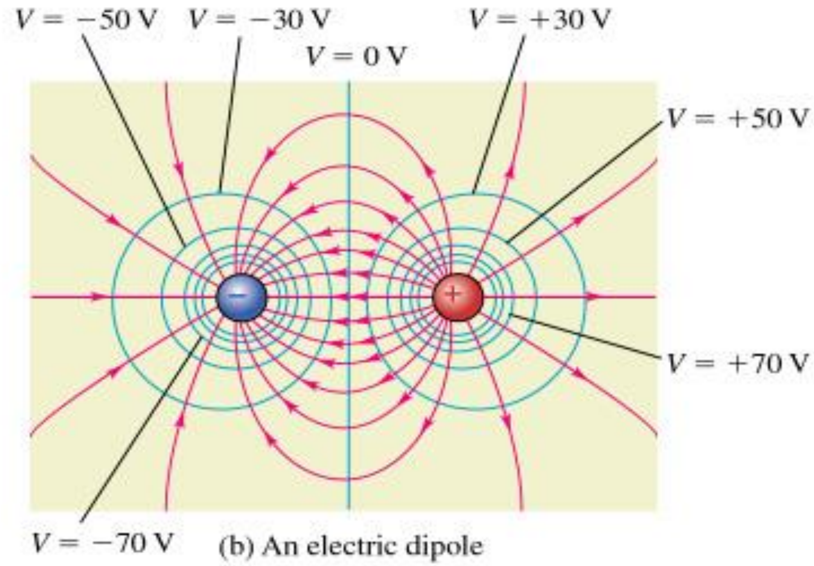
This time

- More on equipotential surface
- Electric potential for a line charge

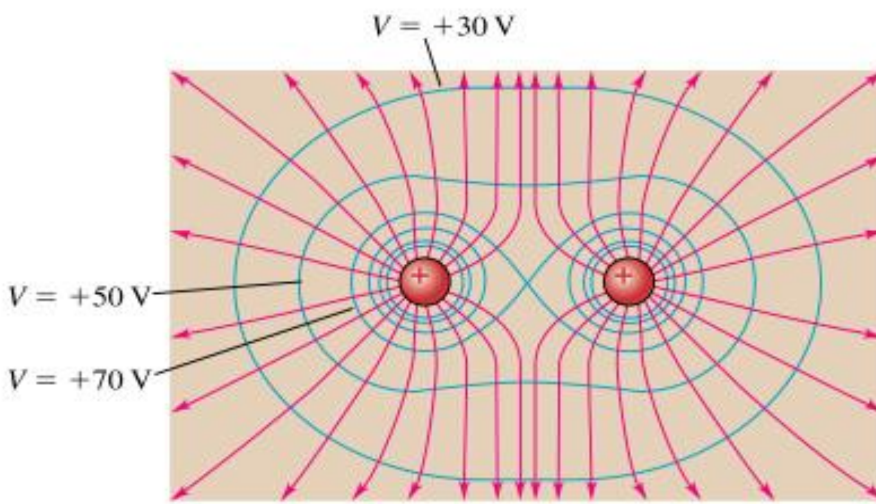
Equipotential Surfaces



(a) A single positive charge

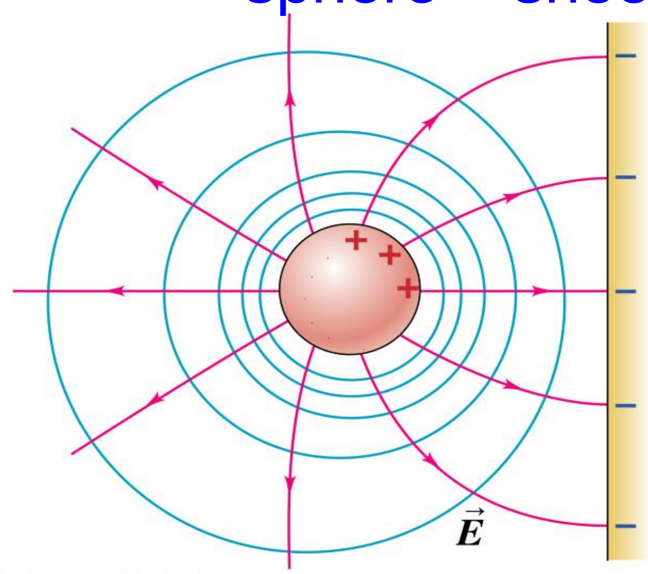


(b) An electric dipole

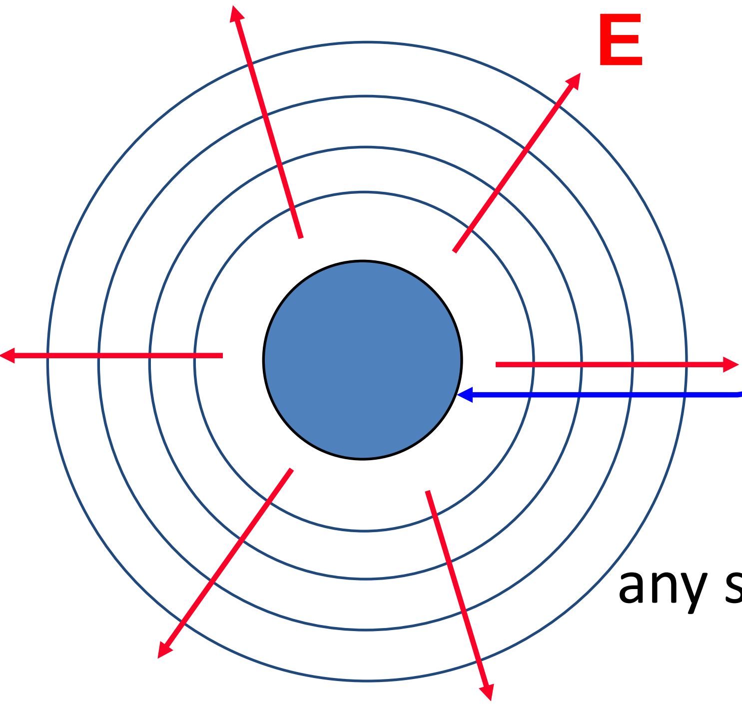


(c) Two equal positive charges

Conducting sphere + sheet



Equipotentials

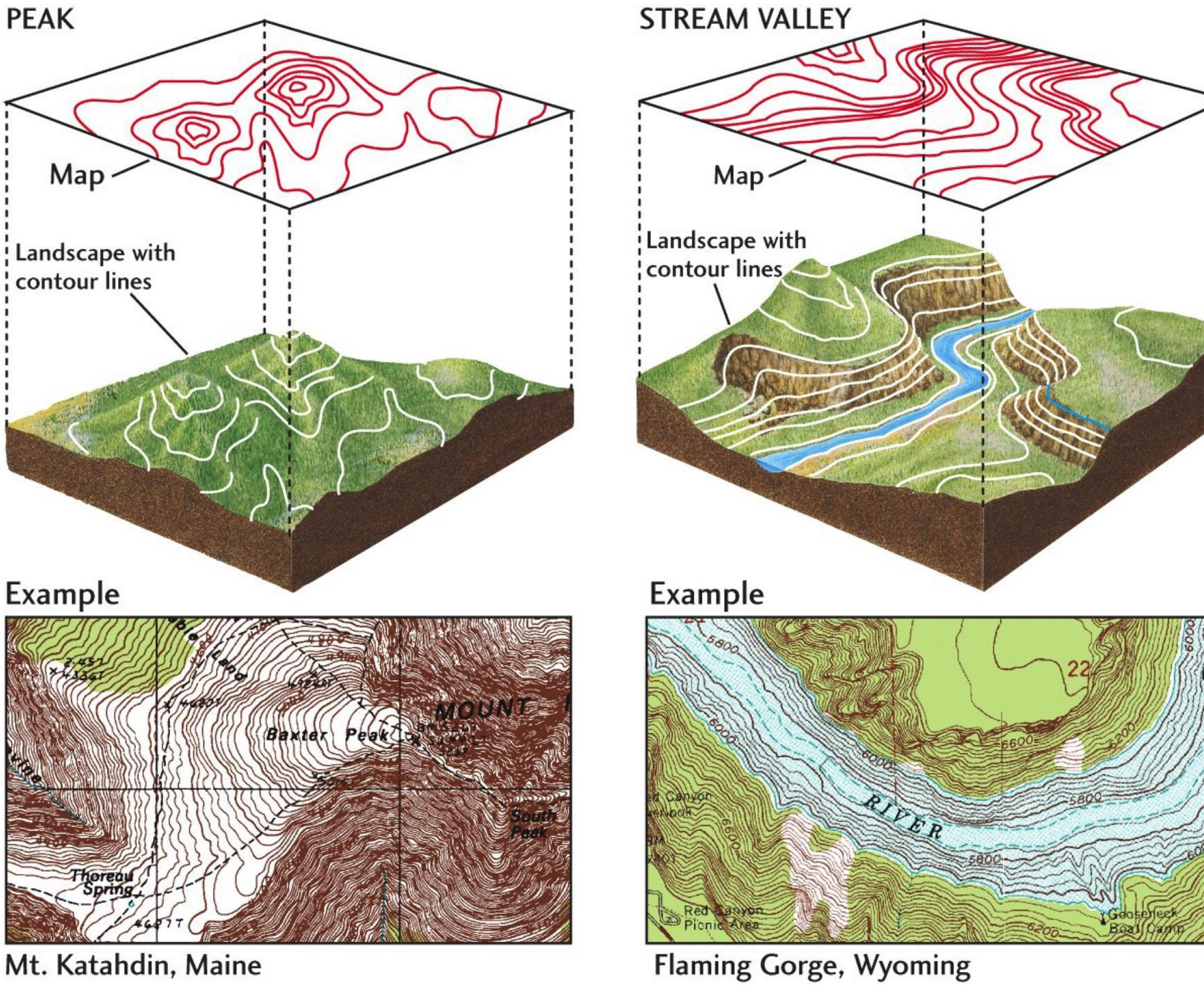


Consider equipotential lines
(or surfaces, actually, in 3-D):

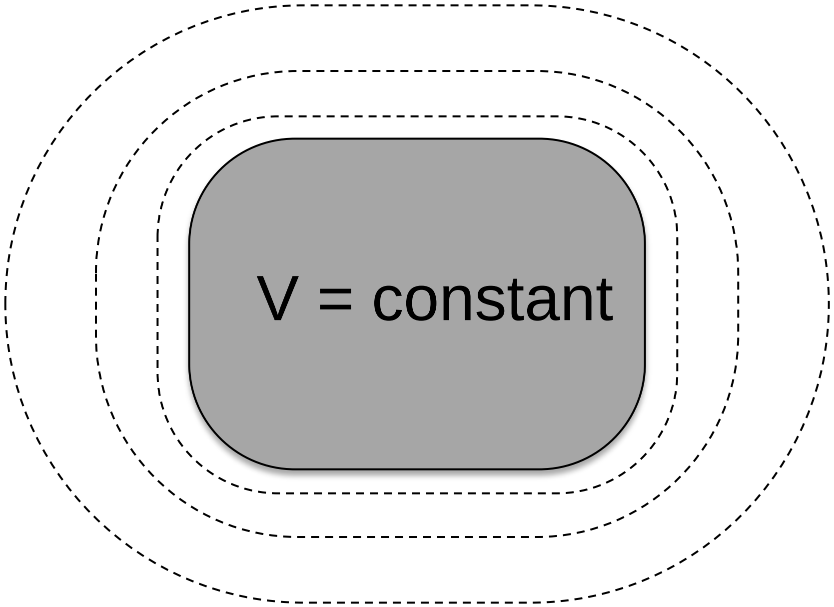
eg --for uniform spherical charge,
$V(r) = k\,Q/r$ is constant over
any sphere concentric with the charged sphere.

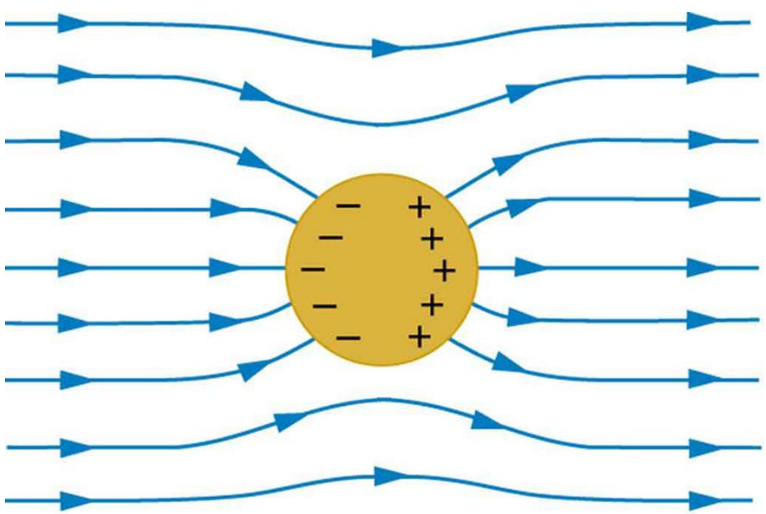
Note that if move along equipotential surface, by definition $\Delta V = 0$, we are moving perpendicular to the elctric field.

Where have you seen equipotentials before?



Conductors and E-fields





A conductor is an equipotential object. If there was a potential difference across the surface of a conductor, the freely moving charges would move around until the potential is constant.

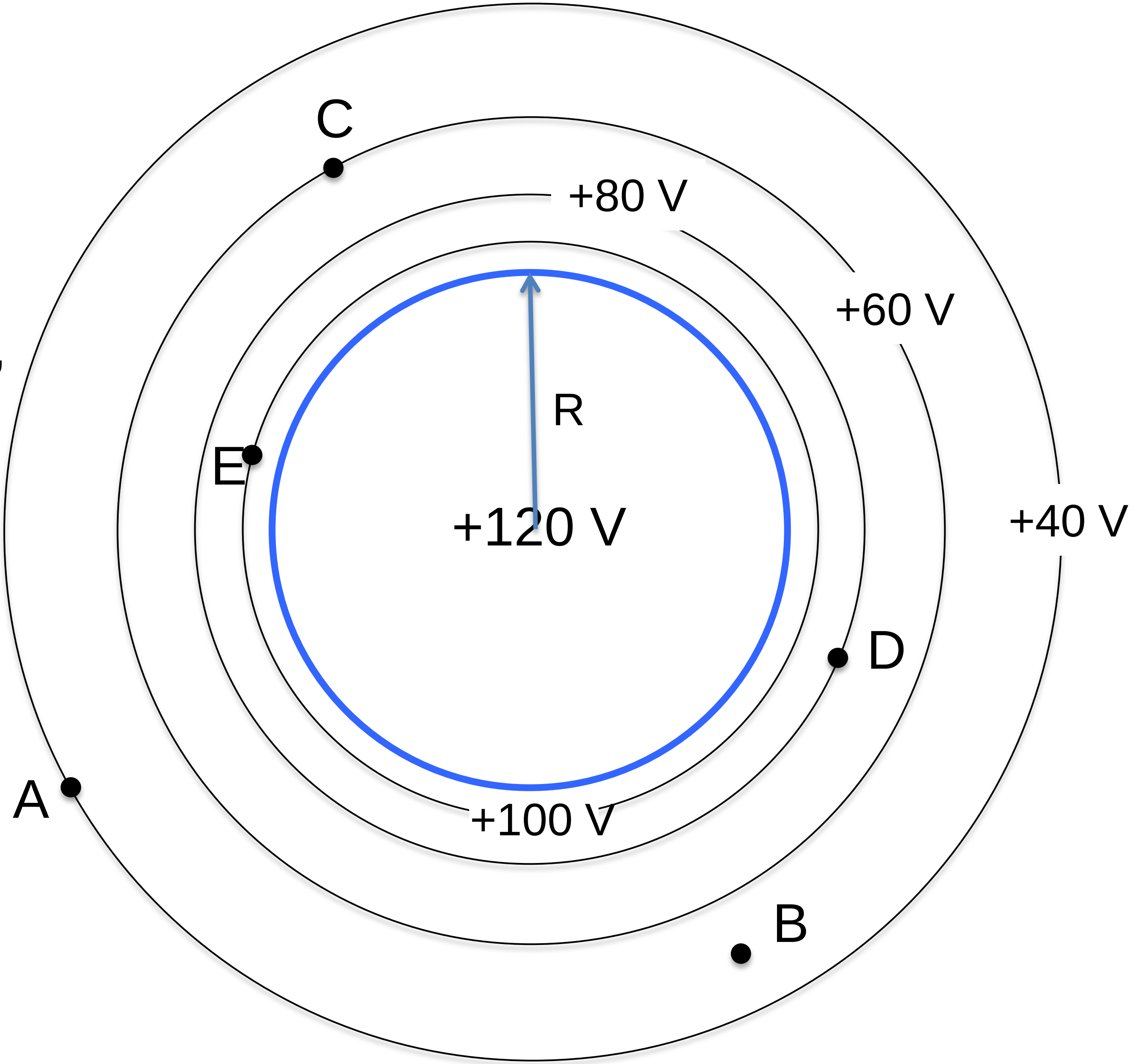
This means that electric field lines ALWAYS must meet a conducting surface at right angles (any tangential component would imply a tangential force on the free charges).

https://cnx.org/contents/Ax2o07Ul@8.8:a8tWDdDr@3/Conductors-and-Electric-Fields

Equipotential surfaces for charged conducting shell

Equipotential surfaces give you information about the potential energy that charged particles would have, the direction of the electric field, the strength of the electric field, and where a charged particle is allowed to go, based on its energy.

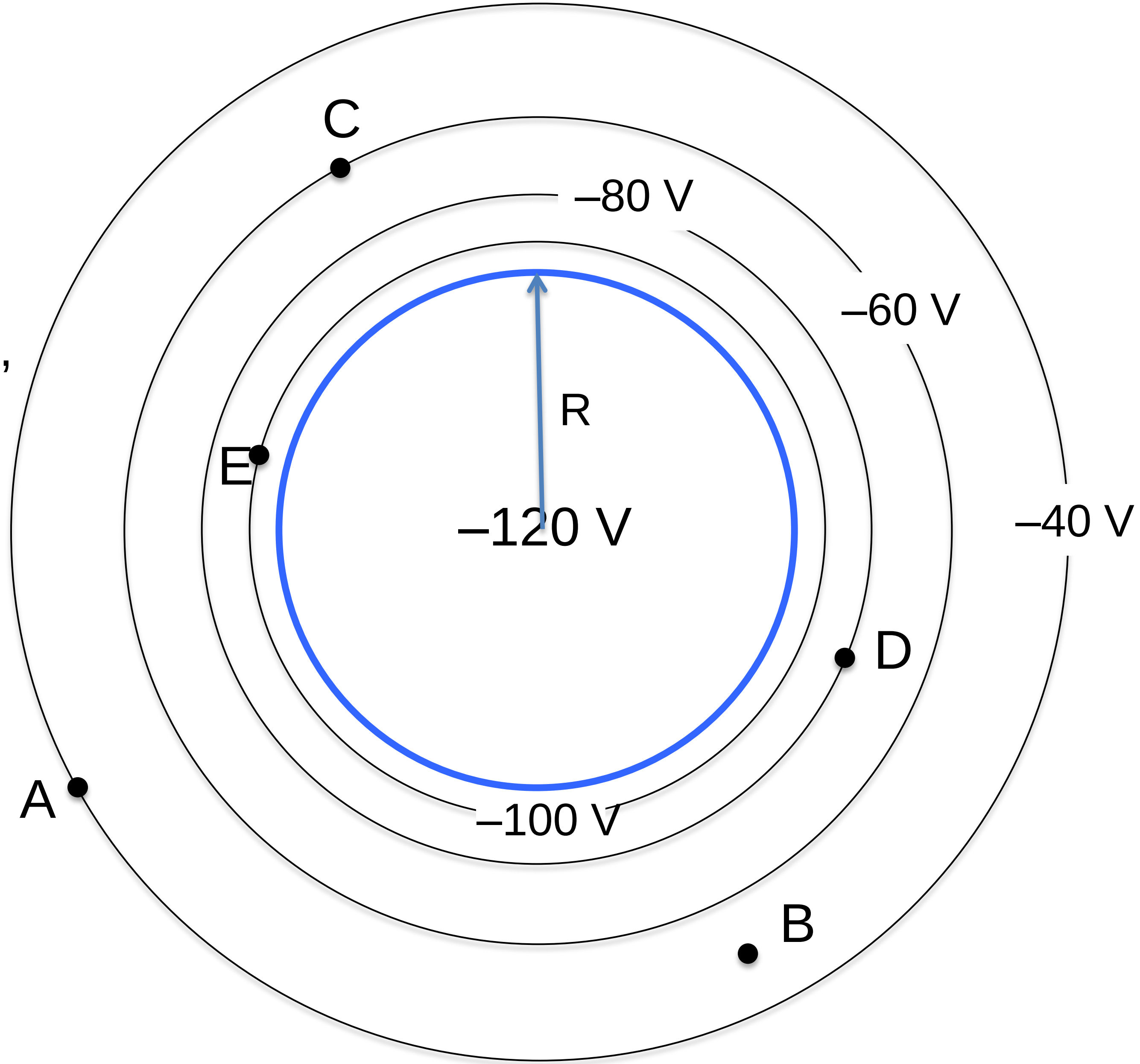
$$V(r) = \frac{1}{4\pi\varepsilon_0}\frac{|q|}{r}$$



Equipotential surfaces for charged conducting shell

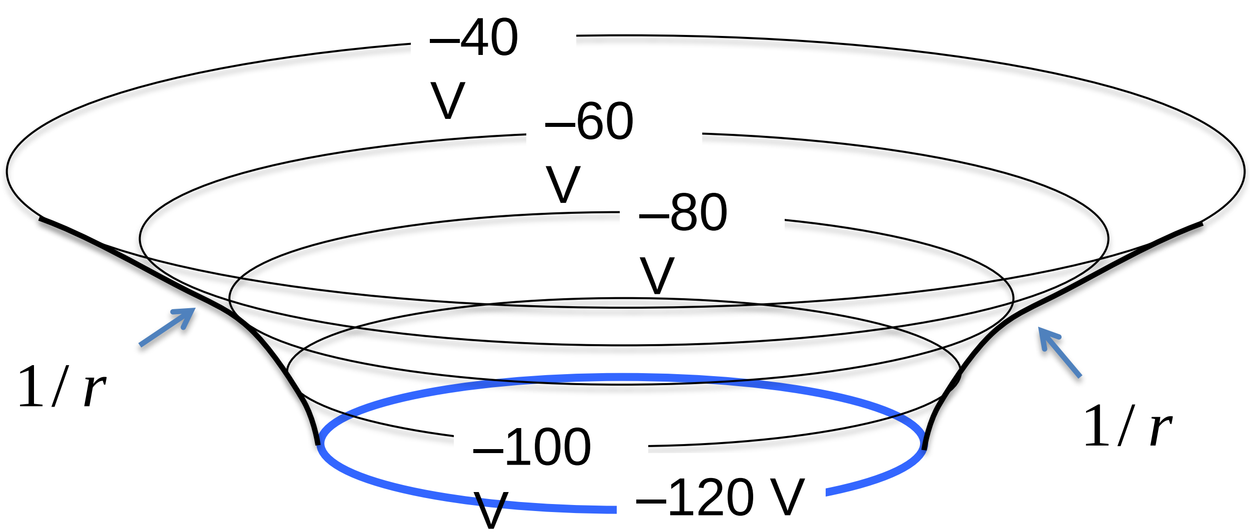
Equipotential surfaces give you information about the potential energy that charged particles would have, the direction of the electric field, the strength of the electric field, and where a charged particle is allowed to go, based on its energy.

$$V(r) = -\frac{1}{4\pi\varepsilon_0}\frac{|q|}{r}$$



Equipotential surfaces for charged shell

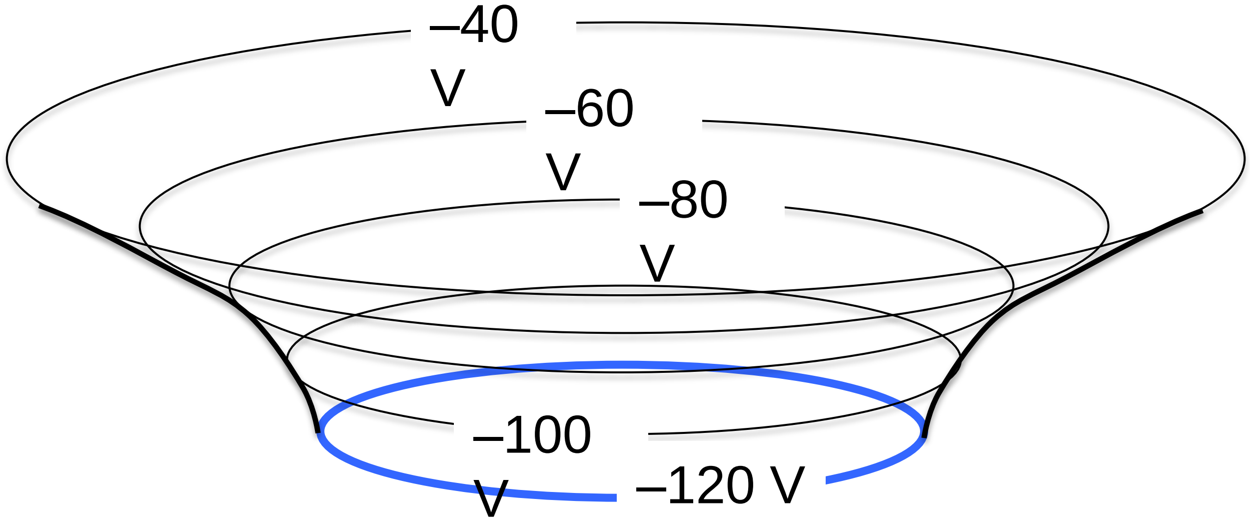
Equipotential surfaces give you information about **the potential energy that charged particles would have**: Think of the electric potential (V) the same way that gravitational potential (gh) is an altitude above sea level. The potential energy of a charge q is then just U = qV, while the potential energy of a mass is U = mgh.



Equipotential surfaces for charged shell

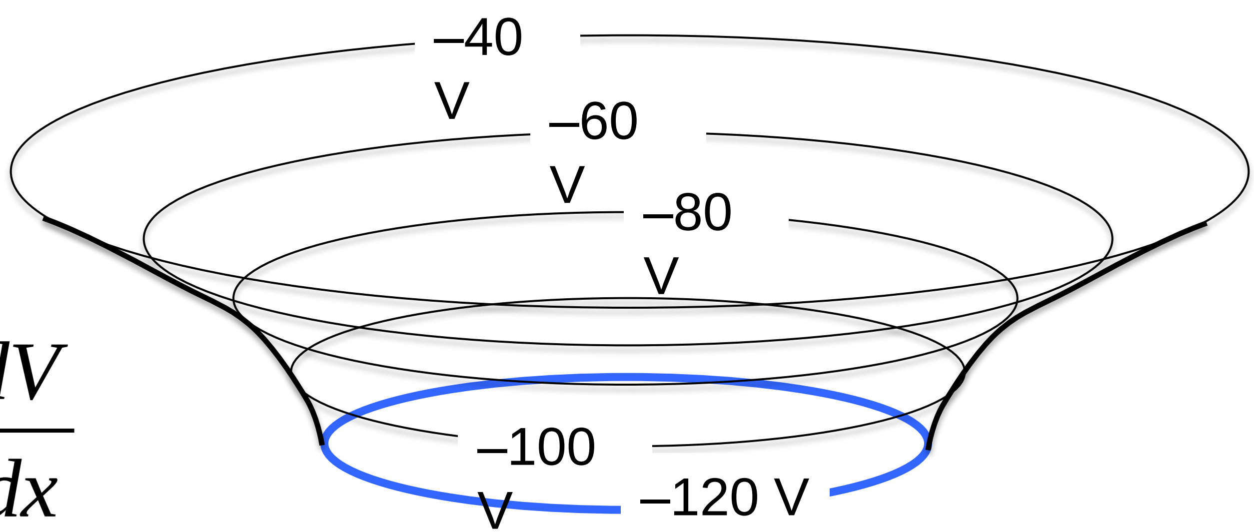
Equipotential surfaces give you information about **the direction of the electric field**. Just like in the gravitational analogy, objects roll downhill (to lower gravitational potential), positive charges move "downhill" to lower electric potential; the electric field always points "downhill".

$$\Delta U = q\Delta V$$



Equipotential surfaces for charged shell

Equipotential surfaces give you information about **the strength of the electric field**. We know that the in the gravitational case, objects on steeper slopes will accelerate faster. Similarly here, the strength of the electric field is related to the slope of V(x). The more bunched together the equipotential lines, the steeper the slope, the stronger the field.



$$E_x = -\frac{dV}{dx}$$

Equipotential surfaces for charged shell

Equipotential surfaces give you information about **where a charged particle is allowed to go, based on its energy**. If you release a marble in a bowl at some height *h*, it will never be able to reach a higher height. Similarly, if you release a positive charge from some potential, it can never reach a higher potential unless supplied with extra energy.