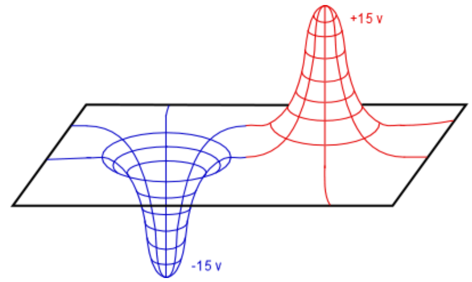
Name: ______________________________ Phys 12

6.05 Equipotential Lines

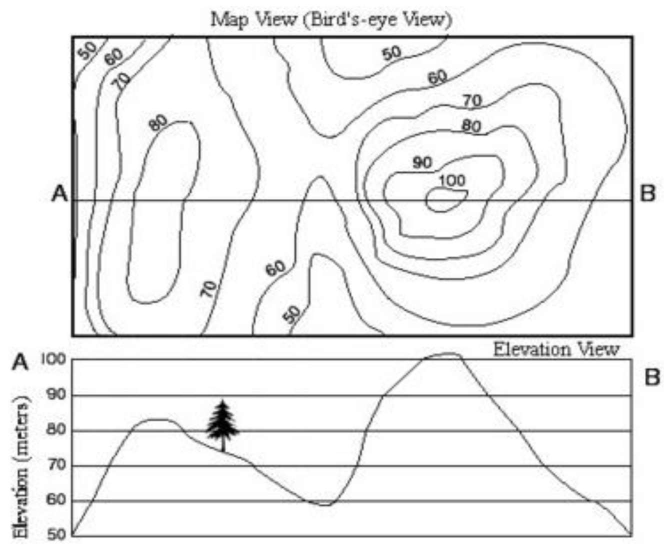
We looked at electric potential last class and it kinda looks like a topographical map:



Topographical Maps:

- Since gravitational potential energy depends on height, lines of constant height would be gravitational equipotentials. A map of such lines is called a topographical map. Typically, a topographical map shows equally spaced lines of constant elevation.

- Where the lines are most closely spaced the elevation is changing most sharply, in other words the terrain is steep.



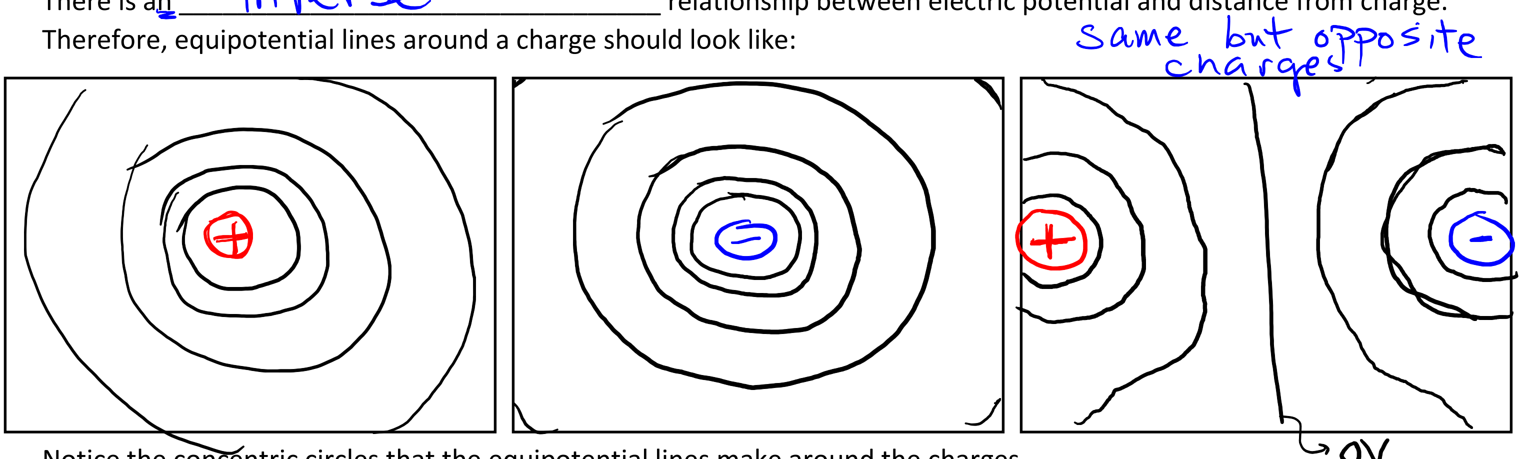
Notice that the lines on a topographical map represent the height elevation. All the points on that line have the **same height above sea level.**

Similarly, **equipotential lines** represent points in space that have the same ___electric potential___.

Based on the formula for electric potential:

$$V = \frac{kQ}{r}$$

There is an ___inverse___ relationship between electric potential and distance from charge.
Therefore, equipotential lines around a charge should look like:



Notice the concentric circles that the equipotential lines make around the charges.
(circles w/ common centre)

If we move a charge from one point on an equipotential surface to another point on ~~an~~ the same equipotential surface, the work done on this charge is ___zero___ because the potential difference between these 2 points is ___zero___.

Take a look at the rate at which electric potential changes spatially on the topographical maps called the ___gradient (slope)___

The spatial gradient for electric potential is actually the.....(wait for it...) ___electric field___!!!

No HW!

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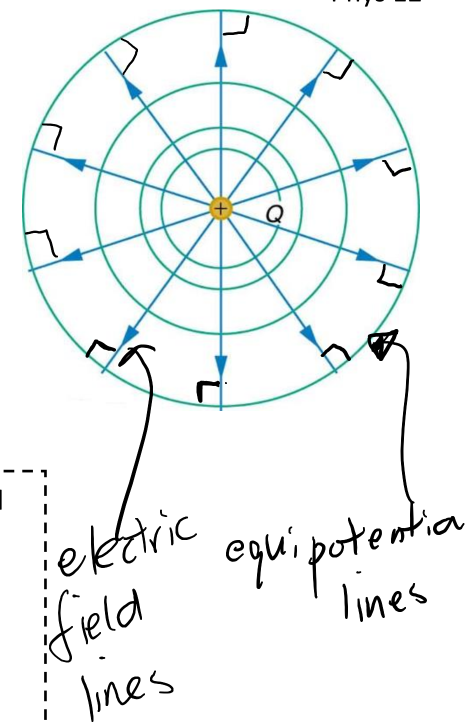
How is the electric field and the electric potential represented visually?



Notice that the electric field lines are ___normal (perpendicular)___ to the equipotential lines (electric potential).

The electric potential and the electric field are related:

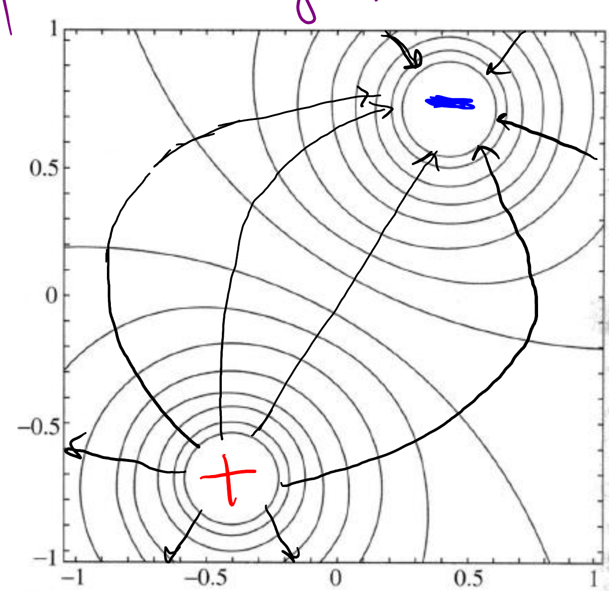
$E = \frac{\Delta V}{\Delta r}$ (In calculus: $E = -\frac{dV}{dr}$)

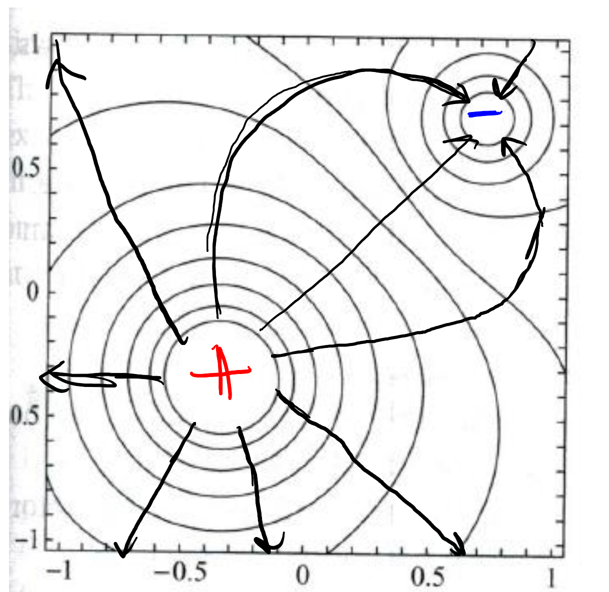
(Why do you think there's an negative sign in the calculus equation?)

If you're in calculus, try this! Solve for the electric field using the equation above and see if you get the equation for electric potential!

$$-\frac{d}{dr}\frac{KQ}{r}$$

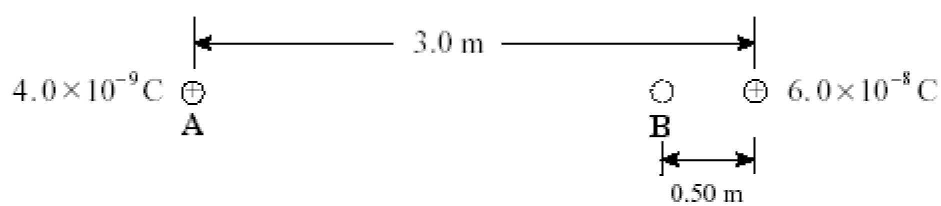
Ex. 1: Draw the electric field lines for the diagram showing the equipotential lines between two equal charges and two unequal (opposite charges) charges:





Do this on the whiteboard/separate sheet of paper (extra practice, not related to above):

Ex. 2: A 4.0 x10^{-9} C charge of mass 2.4 x10^{-21} kg, is initially located at point **A**, 3.0 m from a stationary 6.0x10^{-8} C charge.



a) How much work is required, by an external agent, to move the 4.0x10^{-9} C charge to a point **B**, 0.50 m from the stationary charge?

b) If the 4.0x10^{-9} C charge is now released from point **B**, what will be its velocity when it passes back through point **A**?

No HW!