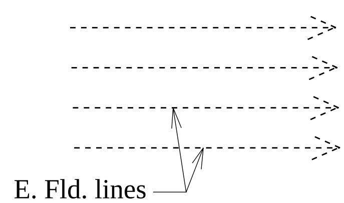
Electrical Potentials -- Conceptual Questions

1.) What does an absolute electrical potential actually tell you? That is:
   a.) Is it a vector? If so, what does its direction signify?
   b.) What does its magnitude tell you?
   c.) How are electrical potentials used in everyday life?

2.) An electrical potential field is oriented so that it becomes larger as you move to the right.
   a.) What will a positive charge do if put in the field?
   b.) What will a negative charge do if put in the field?
   c.) Is there an electric field associated with the potential and, if so, in what direction is it oriented?

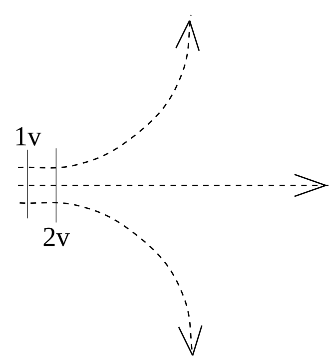
3.) A point charge exists at the origin of a coordinate axis. A distance 2 meters down the *x axis*, the electric field is observed to be 12 nt/C.
   a.) What is the electrical potential at that point?
   b.) You double the distance to 4 meters.
      i.) What is the new electric field?
      ii.) What is the new electrical potential?

4.) You have an electric field as shown. What will equipotential lines look like in the field?

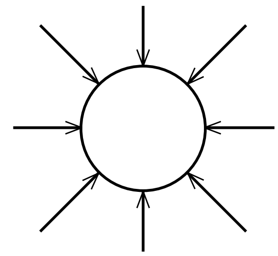


5.) How is the *electrical potential difference* between two points related to the amount of work required to move a charge *q* from one point to the other?

6.) The dotted lines in the sketch to the right are electric field lines. Shown also are the 1 volt and 2 volt equipotential lines. Draw in the 3 volt and 4 volt equipotential lines.



7.) To the right is a cut-away cross-section of a ball of radius *a*. Given the electric field lines as shown:



a.) What do you know about the electrical potential on the surface of the shell?

b.) How would *Part a* have been different if the electric field lines had been oriented outward?

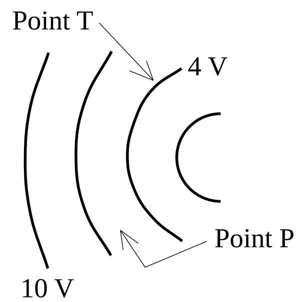
c.) What do you know about the electrical potential inside the cavity?

d.) What do you know about the electric field at the boundary between the *inside* and *outside* of the shell?

e.) What do you know about the electrical potential at the boundary between the *inside* and *outside* of the shell?

f.) Where is the electrical potential zero?

8.) An oddly shaped charge configuration produces the equipotentials shown to the right.



a.) In what direction will a positive charge accelerate if placed in the field at *Point P*? How about *Point T*?

b.) What would be different if a negative charge had been placed at *Point P*?

c.) Is there any region in which the magnitude of the electrical potential field is:

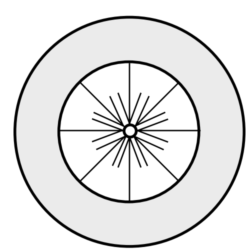
i.) A constant? If so, identify it on the sketch.

ii.) Zero? If so, identify it on the sketch.

9.) What does the electrical potential *V* at a point tell you about the electric field ***E*** at that point?

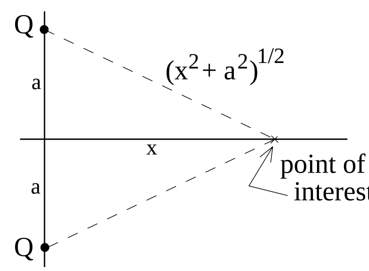
10.) What does the electric field at a point tell you about the electrical potential at that point?

11.) To the right is a cut-away end-view of a thin-skinned conducting PIPE (I know, it looks like a ball--*it's the end of a pipe*) with a thin wire running down its axis. The wire's radius is *a* while the pipe's inside radius is *b* and its outside radius is *c*. Given the electric field lines as shown:



a.) Assume there is -λ*'s* worth of negative free charge per unit length associated with the wire. Looking at the electric field lines, is there any other free charge in the system and, if so, where is it found and how much is there?

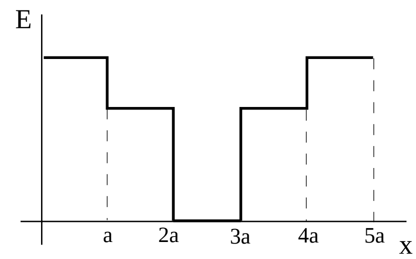
b.) What do you know about the electrical potential outside the pipe?
c.) What do you know about the electrical potential inside the dotted area?
d.) What do you know about the electrical potential inside the hollow?
e.) What do you know about the potential inside the wire?
f.) When using Gauss's Law, we usually start with the innermost region and work our way outward. Why do we do that?
g.) In asking about the electrical potential in this set-up, why did I start with the outermost area and work inward? (After all, that isn't the way we go when dealing with electric fields and Gauss's Law problems.)



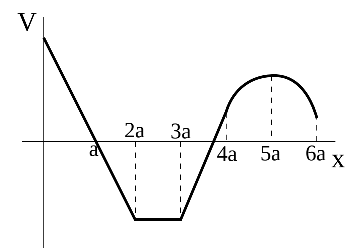
12.) Two equal, positive point charges are shown to the right. The net electrical potential a distance x units down the *x-axis* is $2kq/(x^2 + a^2)^{1/2}$, where k is a constant.

a.) What is the constant k?
b.) Justify the electrical potential expression. That is, use the electrical potential function for a point charge and do the problem.
c.) The electric field function for the situation we're talking about is $2kqx/(x^2 + a^2)^{3/2}(\mathbf{i})$. Using the *point charge* approach, justify this expression.
d.) Using the del operator and the known electrical potential function, can you determine the electric field function presented in *Part c*? If so, do so.
e.) If you try to do *Part d* but with a *negative* charge at the bottom and a *positive* charge at the top, you will run into a hopping big problem. Specifically, because the electrical potential of a positive charge a distance r units from a point of interest is kQ/r, and the electrical potential for a negative point charge is $-kQ/r$, the sum of the two electrical potentials at ANY point down the *x axis* will be ZERO.
i.) How are you going to use the del operator on *that*?
ii.) In fact, if the electrical potential is *zero* down the axis, what does that tell you about the electric field at a point on the axis? Be complete.
iii.) It seems as though the del operator approach only allows you to determine the electric field when the system is a like-charge situation (i.e., a situation like the one in *Part d*). Does this make sense? If not, what do you suppose is the problem?
iv.) What would you have to do to make the del operator approach work in an *unlike-charge* situation? Explain.
v.) Why *did* the approach work as presented in the *like-charge* situation?

13.) The graph of an electric field in one dimension is shown to the right. What would the corresponding electrical potential graph look like?



14.) The graph of an electrical potential field in one dimension is shown to the right. What would the corresponding electric field graph look like?



15.) A charge q in a constant electric field sits at a point where the electrical potential is V_1, where V_1 is positive. It accelerates from rest to a position at which the electrical potential is $2V_1$. At that point, the particle's velocity is v.

a.) Is the charge positive or negative?

b.) If q had gone to a position where the electrical potential was $3V_1$, how fast would it have been going (do this in terms of the known velocity v)?

16.) A positive charge q in a constant electric field is released from rest and travels 10 meters. At the end of the 10 meter run, its velocity is v. How far would it have had to travel to attain a velocity of $2v$?