The figure below shows the electric field lines for a matched pair of positive charges. Exactly halfway between then, the field is zero because the fields they produce individually are of equal magnitude but point in opposite directions. What about the electric potential relative to infinity at that same point? Please discuss qualitatively without relying on equations to support your conclusions. Consider what it would take to get a charged particle to that point.

Common conclusion: zero field implies zero change in potential

Since the electric field is zero at the point in question, due to equal magnitudes of opposing charge, **there will be no displacement along the electric field if a test particle is at the same point. If there is no displacement along the field, then there is also no change in potential**.

Change in position is critical to finding change in potential

The electric potential relative to infinity is based on the idea that when a test charge is moved from one point to another and first position has an infinitely large radius from another actual charge, then mathematically only the final radius of the test charge needs to be considered. **Even though a charge at the specified point doesn't move, there would be a non-zero electric potential because it is assumed that it has moved from a point infinitely far out**. However, voltage is analogous to work, and **since there is no electrical force parallel to the distance travelled, then the electric potential is zero as well**. Based on the electric field drawn, the charges are positive, so a negatively charged particle should not be difficult to place at that point.

Excellent discussion

The electric potential at a point relative to infinity is the amount of energy that would be required to move a charge from someplace arbitrarily far away into that position divided by the charge. Because the quantity of energy is divided by the charge, let us consider some positive charge q (so that all of the signs remain positive) located an infinite distance away from the configuration shown above. **In moving this charge from infinity into the very center of the configuration (directly in between the charges where the electric field is equal to zero), one would be working against some electric force the entire way**. The electrical force is simply the field multiplied by the charge, and the field, in this case, points outward from the configuration. So, as the charge is positive, the force pushes it away. Thus, the field would be doing negative work (force is contrary to the motion) on the charge all the way from infinity to the area seen in the picture. As it drew near to the center of the configuration, the net force pushing the charge away would dwindle until it became zero right at the center, but by this time the field has already performed a rather hefty amount of negative work on the charge. So, the charge should respond by having a very large positive change in its electric potential energy. Then, dividing this positive quantity by the positive charge should yield the electric potential of that point relative to infinity. **Thus, the electric potential at this point relative to infinity is a positive value. Notice that the fact that there is no field there makes no difference. All that the absence of a field means is that at that point, the electric potential doesn't change. As change across a single point doesn't even make sense, the absence of a field makes little difference to the electric potential.**

An incandescent light bulb works by moving charges through an electric potential. Those charges gain kinetic energy, which is converted into heat and light. For an ordinary light bulb that operates at 100 Watts (= 100 J/s), estimate the amount of charge that passes through it in one second. (Typical household wiring operates at 110 Volts, which for purposes of estimation is, of course, ~ 100V, right?)

Electrical energy follows immediately from electrical potential difference

We know the work, so we can find the change in potential energy (delta W=-delta U). Therefore, we know **delta U is -100 J/s**. We can now use the formula **(delta!) V = delta U/ q** to find the charge. -100 J/s / 100 V = **-1 C**

It's all conservation of energy, though it's not kinetic

Since energy is conservative, the **amount of kinetic energy gain** would be equal to the amount of potential energy lost. Since this lightbulb uses 100 Watts, 100 joules would pass through every second. **The electric potential difference is 100 (V!!)** **therefore 1 coulomb of charge would pass through the bulb every second**.

Where is the most convenient place to set electric potential equal to zero when dealing with a single point charge?

a. At that charge's location
b. At the location of test charge you use to probe its influence
c. A standard reference distance 1 meter from the charge
d. Infinitely far away