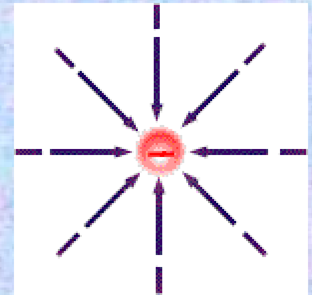
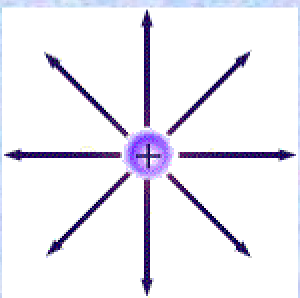
Electric Fields and Potential

Electric Fields

- Without understanding fields, the concept of "action at a distance" was believed.
- Its not the object that exerts the force, it's the field created by the object that exerts the force.
- An electrical field is measured as the force exerted on a small positive test charge.
- Fields point away from positive charges, and point toward negative charges.



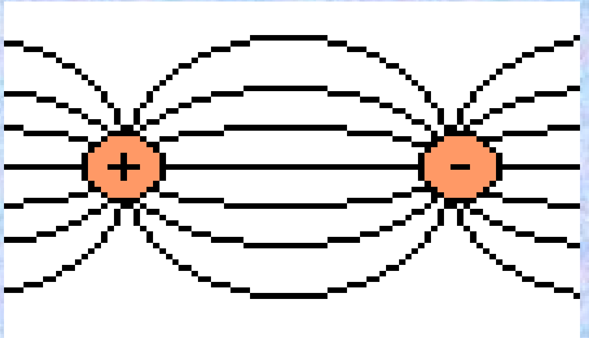


Electric Field Lines

- Field lines represent the vector of the electric field.
- That means the magnitude *and* direction.
- The strength (magnitude) of the field is shown by the length of the vectors.
- To show the true field you would have to draw and infinite number of vectors.
- We show it with field lines (lines of force)

Field Lines cont.

- Where the lines are closer together, the field is stronger, where they are farther apart, it is weaker.
- For an isolated charge, the lines extend to infinity.
- For two opposite charges, they move from the positive to the negative. (book pg 520)
- Electric fields store energy.



Field Strength

- An electric field strength can be calculated by $E = F / q_o$
- E = Electric Field
- F = electric force on a test charge
- q_o = test charge
- Unit is N/C
- For a point charge (or sphere charge) $E=kq/d^2$
- $k = 9.0 \times 10^9 Nm^2/C^2$
- d = distance from the charged object
- q = charge of object

Shielding

- Charges gather on the surface of objects.
- Electrons can move, so they move to the location where the charge is evenly distributed.
- This causes fields inside the object to have a magnitude of zero. Electrons ensure that this is created!
- In irregularly shaped objects, the corners or points will have more charge.
- This ensures that the field inside will be zero.
- This is why electronics are in metal boxes.

Electrical Potential Energy

- An charged object can have potential energy depending on its distance from an electric field.
- Work must be done to move an object against a field, or can be done on the charged particle by the field.
- When the charge is not held in place, this potential energy will be converted to kinetic energy.
- 2 charges will have twice the potential energy as 1, 3 charges 3 times, etc.

Electric Potential cont.

- We focus on electrical potential energy per charge to simplify.
- Electrical Potential energy is measured in Volts.
- 1 Volt = 1 J/1C
- Electrical potential is what we call voltage.
- A high voltage requires a high energy only if a lot of charge is involved.
- Remember, 1 C is a lot of charge!

Electrical Potential Difference

- Since work must be done to move a charge in a field, a difference in electrical potential can be measured. Also called voltage!
- $V = W/q_o$
- V = potential difference
- W = work done (J)
- q_o = test charge (C)

Capacitors

- Electrical energy can be stored in capacitors.
- Two plates are separated by a tiny distance and connected to charging device (like a battery).
- A charge difference is created between the plates depending on the potential difference created by the device, and the distances between the plates.
- $E = V/d$ d= distance between the plates.
- Discharge occurs when a conducting path is created between the plates.