# **Electric Potential**

## **Electric Potential Energy**

Use Coulomb’s law to find potential energy:

(work is negative by convention; acts in the direction opposite to the system)

We must integrate this because the force changes as you get closer:

(if const force)

4.2J = 1 calorie

(These equations are wrong at speeds near the speed of light)

**Electric Potential/Voltage:**  (again, negative by convention)

For a point charge, (decreases as )

A potential difference in a system can cause electrons to move and chemicals to become excited.

Electron-Volt:

**Breakdown Voltage:**

if there is a potential (voltage) difference, 1 electron can be loose in an insulator that would cause an avalanche effect and move a lot more electrons. (Like lightning)

And it causes a shockwave!

In air: (also depends on pressure; lower in high altitudes)

## **Capacitors**

* Between two oppositely charged objects
* No field outside the objects (0 enclosed charge by Gauss’ Law)
* Able to store lots of energy and release it really *fast* (unless it diffuses into air)
* where is the “capacitance” (changes w/ each capacitor), is voltage, and is the charge
* 2 big electrodes (cylindrical plates) (the bigger they are, the more charge they hold)
* so E~V
* Capacitance:
  + Depends on area
  + (area/distance)\*material constant
  + Increase capacitance by putting insulators in between!
  + Measured in “Farads”:
* most important:
* Capacitance:
  + always positive
  + only depends on the material itself: ( is the distance between plates and is the material constant)
    - NOT on voltage or charge!
  + same capacitance even if no charge
* any two conductors make a capacitor
* dipoles will align to a field of charge! (and will move if the field is not homogenous)
* change capacitance: change the material in between:
  + dielectric (insulator with dipoles)
    - will *increase* capacitance
    - dipoles will align along field lines (dipole points from neg. to pos. charge) in an electric field (voltage)
    - they will make another (opposite) field to decrease the total electric field
    - (dipole moment is the distance times the charge)
    - increase the breakdown voltage threshold
    - where is the capacitance in free space
  + conductor
    - increase capacitance
    - but still risk of breakdown threshold and not touching either side
    - (effectively reduces capacitor length)
* Combining Capacitors
  + Parallel
    - has to have same voltage on each capacitor, so:
  + Series
    - The same *charge* has to be on all capacitors
  + To calculate, look at smallest part and treat it as one capacitor