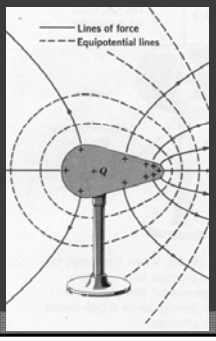
Capacitance

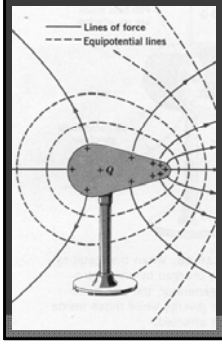
2 – ELECTRIC CIRCUITS

Shape and Charge



- Sphere has a uniform charge density (charge/area)
- Charge acquired by a conductor distributes itself according to the surface curvature, concentrating around points.

Shape and Charge



- Discharging Effect of Points
  - If field is strong enough it can ionize gas molecules in air
  - Positive ions and electrons respond to electric force.
  - When air is ionized, point of conductor is rapidly discharged
  - Always some ions present and collisions produce more
  - That is why air is ionized rapidly

Ionizing Air

- In dry air, if the potential gradient (E) = 30 kv/cm between 2 charged surfaces then the air will ionize and a spark discharge occurs.
- A rush of free electrons and ionized molecules discharging surfaces and producing heat, light and sound.
- Usually the quantity of static electricity is small and time duration of spark discharge is very short.

Ionizing Air

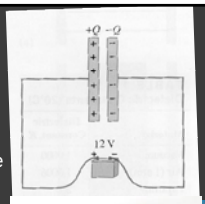
- In lightning the quantity of charge is great!!
- E is still 30kV/cm!!
- It is a rush of charges to meet opposites: cloud-cloud or cloud-Earth

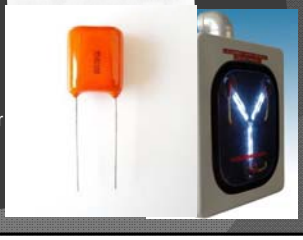
St. Elmo's Fire

- Intensity of electric field at corners is strong enough to ionize air resulting in a violet glow.
- The coronal discharge results in St. Elmo's fire.
  - tips of ship masts
  - trailing edges of wing and tail surfaces of aircraft

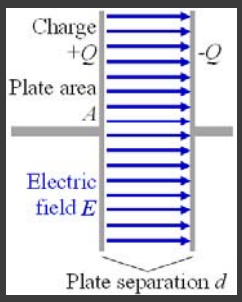
Capacitors

- Any isolated conductor can retain a charge.
- You can increase charge until there is a spark discharge.
- In a vacuum, it can withstand more charge
- A combination of conduction plates separated by an insulator that is used to store an electric charge is known as a ***capacitor***





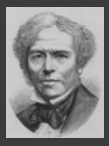
Capacitors



- What determines the charge that can be placed on a capacitor?
  - a. area of plates
  - b. distance of separation
  - c. char. of insulating material

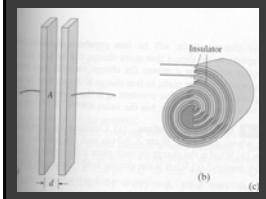
Capacitors

- The larger the charge, the greater is E between plates
- Ratio of q:V is a constant for a given capacitor- *Capacitance*
- C = ratio of q:V
- C = q/V



- C is measured in farads
- C = 1f when a charge of 1 c on a capacitor results in a V of 1v between plates

Dielectric Materials



- Dielectric Materials-- Faraday
- Effect of different insulating materials between plates of capacitors
  - using plates of equal area and spacing and comparing with air,
  - C_2 had greater charge than C_1(air) by a factor of K
- $q_2 = Kq_1$ $q_2/V = K\, q_1/V$
- thus $C_2 = KC_1$

Dielectric Materials

- Materials used to separate plates of capacitors are known as dielectrics.
- K, dielectric constant
  - dry air K = 1.0006
  - (unity w/ vacuum)
  - dimensionless
  - $K = C_2/C_1$

DIELECTRIC CONSTANTS AT 25°C

Dielectric Material	K (Dielectric Constant)
Vacuum	1.0 (exact)
Air	1.0001
TFE	2.0
Polystyrene	2.5
Polypropylene	2.5
Polycarbonate	2.7
Polysulfone	2.7
Polyester	3.0
Polymide	3.2
Polyethylene	3.3
Kraft Paper (impregnated)	2.0 to 6.0
Mica	6.8
Aluminum Oxide	7.0
Tantalum Oxide	11.0
Ceramics	35.0 to 6000+

Figure 2

Emily's Baby