The Electric Field

16.3

Objectives

- **Calculate** electric field strength.
- **Draw** and **interpret** electric field lines.
- **Identify** the four properties associated with a conductor in electrostatic equilibrium.

Electric Field Strength

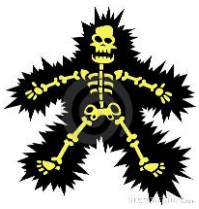
- An **electric field** is a region where an electric force on a test charge can be detected.
- The SI units of the electric field, *E,* are Newtons per coulomb (N/C).
- The direction of the electric field vector, **E,** is in the direction of the electric force that would be exerted on a small **positive** test charge.

Electric Field Strength

- Electric field strength depends on charge and distance. An electric field exists in the region around a charged object.
- Electric Field Strength Due to a Point Charge

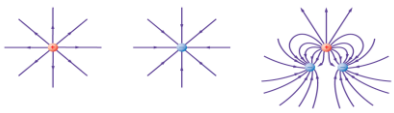
$$E = K\frac{q}{r^2}$$

Math Video!



Picturing the Electric Field

- An **electric field line** is used to represent the actual field surrounding a charge.
- What direction do the arrows point for a **positive** charge?
- What direction do the arrows point for a **negative** charge?
- What is happening in this picture?



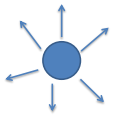
Picturing the Electric Field

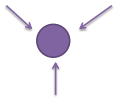
- The number of field lines depends on the charge.
  - The larger the charge, the more lines you will see
  - The closer the lines, the more field strength
  - They NEVER cross each other
- The number of field lines will be given to you.
- Example
- A +1 charge has 2 lines
  - Draw a + 3 charge

- A +2 charge has 2 lines
  - Draw a -3 charge

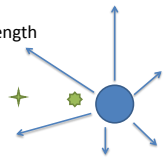
Picturing the Electric Field

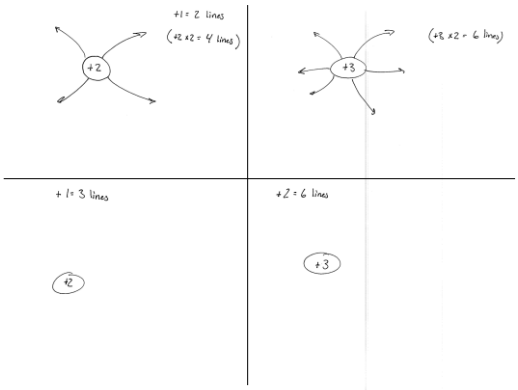
- The larger the charge, the more lines you will see

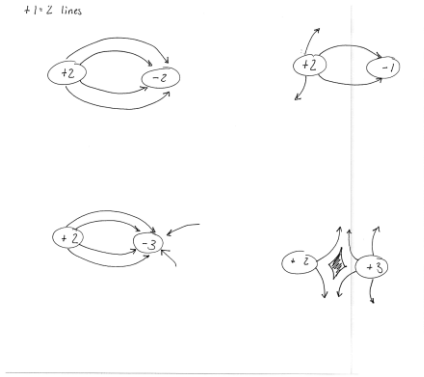




- The closer the lines, the more field strength
  - Feel less field strength
  - Feels more field strength







You Try!

- A +1 has <u>3 lines</u>
- Interaction of a…
  - +1 and a +2
  - - 3 and +2
  - - 4 and - 2
  - +3 and - 4

Disclaimer

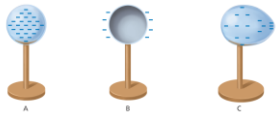
- I should mention that the actual lines do NOT exist. They are just a representation of the electric field.
- The electric field on the other hand DOES exist.

Conductors in Electrostatic Equilibrium

- The electric field is zero everywhere inside the conductor.
- Any excess charge on an isolated conductor resides entirely on the conductor's outer surface.
- The electric field just outside a charged conductor is perpendicular to the conductor's surface.
- On an irregularly shaped conductor, charge tends to accumulate where the radius of curvature of the surface is smallest, that is, at sharp points

Electric Fields Near Conductors

- When a conductor has a charge, this charge is spread out as far as possible. (keep NRG low)
- On the outside of a conductor, however, the electric field often is not zero.
- Even though the surface of a conductor is at an equipotential, the electric field around the outside of it depends on the shape of the conductor, as well as on the electric potential difference between it and Earth.



Electric Fields Near Conductors

- The charges are closer together at sharp points of a conductor, (image C)
- Therefore, the field lines are closer together and the field is stronger.
- These electric fields can become so strong that when an electron is knocked off, it causes a chain reaction and produce plasma. (Plasma Globe)