Demo:

balloons on a string
comb and water

The negatively charged balloon induces movement of electrons within the two pop cans. With electrons moving from Can A to Can B, the two-can system becomes polarized. Once the two cans are separated using the insulating handle, Can A has a + charge and Can B has a - charge.

Applet for field lines

http://www.cco.caltech.edu/~phys1/java/phys1/EField/EField.html
Electric Charge and Electric Fields
Static Electricity is the study of unbalanced charges, not the study of electrons at rest.

It is the study of Voltage or how big is the "unbalance"?.

Dynamic or Current Electricity is the study of the movement of the electrons in an electrically unbalanced object.
Warning:

Beware of the word "electricity." It has several contradictory definitions.
So don't ask "WHAT IS ELECTRICITY?".

Instead, discard the word "electricity" and begin using the correct names for all the separate phenomena. Here are a few of them:

- What is electric charge?
- What is electrical energy?
- What are electrons?
- What is electric current?
- What is an imbalance of charge?
- What is an electric field?
- What is voltage?
- What is electric power?
- What is a spark?
- What is electromagnetism?
- What is electrodynamics?
- What is electrostatics?
- What are electrical phenomena?
Static Electric forces:

- hold atoms together into molecules
- are responsible for the functioning of the nerves in a body
- Most of the transistors in modern TVs and stereos and CPU's are Field Effect Transmitters that are based on electrostatics.
- ATP is assembled by an enzyme which is run by a tiny rotating electrostatic motor! (A typical human body contains around $10^{16}$ of these rotary electrostatic motors. 1997 Noble Prize Material)
- Produce the energy from radioactive decay.
Review of atoms

- atoms are made up of protons, neutrons and electrons.
Review of atoms (continued)

- an atom that has the same number of protons as electrons is electrically neutral (neutral atom)

- an atom with an unequal number of protons and electrons is called an ion.

- an atom that has more protons then electrons is electrically positive (cation)

- an atom that has fewer protons then electrons is electrically negative (anion)
Charged objects as an Imbalance of Protons and Electrons

- The principles applied to atoms can also be applied to objects.

- An object that has the same number of protons as electrons is electrically neutral (neutral or uncharged object).

- An object with an unequal number of protons and electrons is called a charged object.

- An object that has more protons than electrons is electrically positive (positively charged object).

- An object that has fewer protons than electrons is electrically negative (negatively charged object).
When the unbalanced forces are opposite in charge they attract.
When they are like in charge they repel each other.
Charge as a Quantity

• like mass, the charge of an object can be measured.

• the unit of charge is the Coulomb. (C)

  The unit of a Coulomb is very large. It takes $6.25 \times 10^{18}$ electrons to have a total charge of -1 Coulomb (-1C).

• the charge on a single electron is $-1.60217646 \times 10^{-19}$ C

• the charge on a single proton is $+1.60217646 \times 10^{-19}$ C

• charge on an object = (#particles)(charge per particle)
Example: a) An object has $1 \times 10^6$ excess electrons. What is the charge on the object?

\[
\text{Charge} = (1 \times 10^6 \text{e}^-)(-1.602 \times 10^{-19} \text{C}) \\
= \text{Answer: } -1.6 \times 10^{-13} \text{ C}
\]

b) An object has $3.5 \times 10^8$ protons. What is the charge on the object?

\[
\text{Charge} = (3.5 \times 10^8)(+1.602 \times 10^{-19} \text{C}) \\
= +5.6 \times 10^{-11} \text{C} \\
\text{Answer: } +5.6 \times 10^{-11} \text{ C}
\]
Example: An object has $8.25749 \times 10^{17}$ protons and $5.26 \times 10^{14}$ electrons. What is the charge on the object?

\[ (8.25749 \times 10^{17} - 5.26 \times 10^{14}) = \]

\[ 4 \times 1.602 \times 10^{-17} \text{C} = \]

Answer: $1.322 \times 10^{-1}$ C
Definitions:

**Source charge:** the object that is creating the field.

  Analogy: the Earth is an object creating a gravitational field.

**Test Charge:** an electric charge brought into the field created by the source charge.

  Analogy: the falling rock is the object testing the strength of the gravitational field.


Electric Fields

Electric fields are produced at a distance from the charge.

No contact is necessary for a charge to influence neighboring charges.

They produce non-contact forces.
What is an electric field?

An electric field (e- field) is the region in space around a charge where a positive (+ve) test charge experiences a force.

test charge - a charge so small that it does not disturb the distribution of the other charges being measured.
Mathematically we define the electric field as the electric force per unit charge. 

\[ \vec{E} = \frac{F_e}{q} \]

= \frac{\text{Newtons}}{\text{Coulomb}}

= \frac{N}{C}

\( E = \text{energy} \)

\( \vec{E} = \text{electric field strength} \)

= the force per unit charge on the TEST CHARGE
Electric Field lines
-a very useful concept in dealing with electric fields is that of electric field lines.

-These are imaginary lines similar to those we used to describe a gravitational field.

- There are two different types of charge (+ve and -ve) that each create an electric field around them.

- Represent the direction of the electric field.

- Some times called "lines of force"
Point Charges

What kind of Force would a test charge (always positive) experience near a positive charge? A negative charge?
Read - What is a charge handout
Read - pages 2-6 in booklet
Complete questions on page 28