

Lesson 6: History & Theories of Static Electricity

Ancient Times

If you ask most people who discovered electricity, they'll probably tell you [Benjamin Franklin](#) did.

- This is because everyone has heard the story of Franklin flying his kite during a lightning storm.
- This is **NOT** when electricity was discovered!
 - Electricity was first mentioned in the works of a Greek scientist named [Thales of Miletus](#) in about 600BC!
 - Thales noticed that if [amber](#) (hardened tree sap) was rubbed, it had the ability to pick up dust and leaves
 - What he was seeing is what we now call “static electricity”
 - Another Greek named Theophrastus noticed in 300BC that other substances had static electricity if rubbed.
 - Unfortunately neither Thales nor Theophrastus had any scientific explanation for it... they just thought it was interesting.



Illustration 1: Amber pendants (photographed by Adrian Ringstone)

What they did realize was that sometimes two objects would attract each other, sometimes they would repel.

- This developed into the idea that there are two kinds of charge (we call them positive and negative today, which will be discussed shortly).
 - Like charges repel
 - Opposite charges attract.
- This is usually called the **Law of Charges**.

Middle Ages

In 1600AD an Englishman named [William Gilbert](#) started studying these phenomena.

- He wanted to come up with a good scientific explanation for these ancient discoveries.
- He was actually the first person to use the word “electric,” which is a variation of the Greek name for amber.
- Although he had only some success in describing electricity, he was able to show that there were differences between magnetism and electricity that seemed to indicate that they were completely different things.
 - For example, an amber rod had to be rubbed to have electric effects; a magnet was always a magnet (didn't need to be rubbed).
- Up until that point most scientist had believed electricity and magnetism were just different versions of the same thing.

DID YOU KNOW?
William Gilbert was the Court Physician to both Queen Elizabeth I and King James I. This meant that he acted as an adviser in scientific matters

The “Franklin” Era

Benjamin Franklin’s Experiments

Benjamin Franklin (1706-1790) started his investigations after Gilbert.

- Yes, he did fly a kite on an overcast day (no actual lightning), but he wasn’t the first person to do it!
 - Several people had tried to do it before him to prove that lightning was electrical, but they’d all been killed.
 - Most people thought he was a nut to do it. In fact, he had his son set up most of the equipment while he stood back.
 - Franklin was able to prove that lightning was a discharge of static electricity (this does **NOT** mean he discovered electricity!!!)

Most of Franklin’s research actually focused on amber rods...

- It had been found that if a rubbed **amber** rod was dangling from a string, and another rubbed **amber** rod was brought near, the dangling one would move away.
- If a dangling rubbed **glass** rod is brought near another rubbed **glass** rod, the dangling one would move away.
- If a rubbed **glass** rod and **amber** rod were brought near to each other, they were attracted.
- Therefore, the charge on the **glass** must be different from the charge on the **amber**!

Franklin decided to say that...

- the **glass** rod had a **positive** charge
- the **amber** rod (or the plastic **ebonite** used today) had a **negative** charge

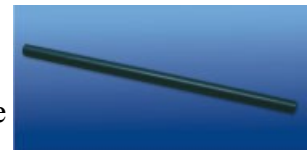


Illustration 2: Ebonite is a type of plastic often used in physics because it can easily build up a static charge.

Why did he choose to call **glass positive** and **amber negative**?

- No reason! He knew they were different and opposite to each other, so he just picked one to be **positive** and the other **negative**.

Franklin’s Single Fluid Theory

Franklin developed what he called a “*single-fluid*” theory to explain the results he was getting.

- According to this theory, all matter contains an “*electric fluid*”, a substance that Franklin thought all matter in the universe had. His *electric fluid* had a **positive charge**.
 - An object with a positive charge has an excess (too much) of this positive electric fluid.
 - An object with a negative charge has a deficiency (too little) of of this positive electric fluid.

Franklin backed up his theory with the observation that if a certain amount of charge is produced in one object, an equal amount of *opposite* charge is produced on another object.

- For example, lets say you rub a balloon on your head. The balloon will gain just as much **negative** charge as your hair will gain **positive** charge.
 - According to this model, the electric fluid flows from one object to the other.
- Franklin used the idea of **negative** and **positive** to figure out algebra problems, since if you charged anything, the two objects’ charges would add up to zero.
 - This would be like if you rub a plastic ruler with a paper towel. The ruler has a **negative** charge, and the paper towel and equal **positive** charge. The charges are separate from each other, but add up to zero.

Modern Theories

Although Franklin's single fluid theory is not exactly right, it did lead him to a law that we still use today in physics...

Law of Conservation of Charge

The net amount of electric charge produced in any process is zero

This just means that even though you can move around charges, you can't create or destroy them.

Example 1: You have two similar objects; one of them has a charge of +7, and the other has a charge of -3. They touch, share their charges, and then are moved apart. Determine the final charge of each of the objects.

When the two objects touch, their charges will redistribute. We need to add them algebraically, and then figure out what the charge on each is.

$+7 + -3 = +4$ <<< This is the total net charge between the two objects.

$+4 / 2 = +2$ <<< Since the charge is shared between the two objects, each is +2.

The net charge at the start was +4, and the net charge afterwards was still +4.

In the past 100 years it has become clear that these charges depend on the makeup of the [atom](#) itself, not on some "fluid"

- The nucleus is made up of **protons (positive)** and **neutrons (neutral)**, surrounded by **electrons (negative)** in orbit.
- In a "normal" state the **electrons** and **protons** balance out, so the charge is **neutral**.

Sometimes the atom may lose or gain **electrons**.

- Nothing happens to the stable nucleus made up of **protons** and **neutrons**.
- It is the **electrons** that are being stripped off or added on because they are on the far outside edge of the atom.
- If the atom loses electrons it will have a **positive** charge... if it gains electrons it has a **negative** charge.
- Either way, it is now called an **ion**.

Usually when an object is charged by rubbing, the charge only lasts a little while... where does the charge go?

- Most of the charge "leaks off" to water molecules in the air
 - Remember, water is a polar molecule, which means one end is more **negative** and the other is more **positive**.
 - The **positive** end can temporarily pick up **electrons**.
- This is why there is more static electricity in the winter.
 - The air is more dry, so the electrons aren't picked up as often.

Homework

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