**Physics 12 – Intro to Static Electricity**

Wow! The course is just zooming by. Aren’t you like totally impressed? We’ve been doing a lot of good physics in the old classic mode, but it is, now, in the words of Monte Python, time for “something completely different”. It is time for electric fields and static electricity!

***History:*** Electricity was first described (that we know of) by an ancient Greek, the philosopher Thales (640? - 546 B.C.E.) in the 580’s B.C. What Thales noted was that when he rubbed a chunk of amber with a piece of cloth, the amber would attract small bits of stuff – fibers, dust bunny bits, fluff, etc. The word for amber in Greek, elektron, gave its name to the phenomenon. Thales didn’t do much with the idea which, truthfully, isn’t all that exciting to begin with, so the thing sort of languished around for a very long time.

We now make a giant time shift leap type thingee to the 17 th century. To 1600 to be specific. It was in this year that the English physician and physicist William Gilbert, having begun to play around with the attractive force of electricity found other substances that could be charged up besides amber. He divided materials up into classes. The classes were:

***Electrics*** - stuff that gains charge and can attract things when rubbed.

***Nonelectrics*** - stuff that doesn't gain a charge.

Electrics were materials like glass, amber, silk, and rubber. Nonelectrics were mostly metals

In the 1660's, the German physicist Otto von Guericke build the first static electric charging machine. He took a large ball of sulfur and rigged it so he could rotate it with a crank. As the ball rotated he pressed a piece of leather against it and the ball would gain an electric charge. Later he built an improved machine that used a glass globe. He used the machine to generate large sparks.

At this time, electricity was thought to be a fluid. They also thought that fire was a fluid, so electricity was commonly called “electric fire”.

Guericke also discovered that static electricity could both be attractive and repulsive.

Around 1709 Francis Hauksbee, a British Scientist, began to experiment with Guericke’s machine. In one of his experiments, he placed a small amount of mercury inside the globe. He cranked the machine in the standard way. When he touched the surface of the globe with his hand, the globe gave off a flash of light.

In 1729 Stephen Gray, an English physicist, found cork acted as a ***conductor***. A conductor is a substance that allows charge to travel through it. This introduced the idea that there were materials that were conductors and materials that were ***insulators***. It turns out that conductors are Gilbert’s nonelectrics and insulators are the electrics. Insulators stop the flow of charge.

In 1733 Charles Du Fay, a French physicist, discovered that there were two types of electric charge. He found that the charge on a glass rod was different than the charge on a piece of amber. He named the charge on a glass rod ***vitreous*** electricity. The electricity on the amber was called ***resinous*** electricity.

In the 1740’s, Benjamin Franklin, the famous American printer and founding father, found that the vitreous electric charge could cancel out the resinous electric charge. He also came up with the names we use today for the differing charges, positive and negative charge.

***Electric Basics:*** Electricity is an aspect of one of the four fundamental forces in the universe, the electromagnetic force. It involves attraction and repulsion between charged particles. The source of the charge is two subatomic particles, the electron and the proton. Electrons have a negative charge and protons have a positive charge. The magnitude of the charge is the same for each particle. We say that an electron has a charge of “minus one” or – 1. The proton has charge of “plus one” or + 1. All this minus one or plus one stuff is mainly a chemistry thing. In physics we use a different unit for charge, as we shall see.

Atoms are electrically neutral – they have no charge. This is because they have the same number of electrons as protons and their charges cancel each other out. If an atom gains or loses electrons, it gains a charge and becomes an ***ion***. We say it is ***ionized***. Ions are a really big deal in chemistry, but not much of a thing in physics.

Different elements vary widely in their ability to gain or lose electrons. This is what is involved when you rub an object with a cloth to give it a charge. You blow up a rubber balloon and rub it with a bit of wool. The balloon is more attractive to electrons than is the cloth, so during the rubbing, electrons from the cloth jump onto the balloon. This gives the balloon a negative charge because it now has more electrons than protons. The cloth gains a positive charge (it has more protons than electrons so the net charge is positive). Rubber objects almost always gain a negative charge during rubbing operations.

A glass rod rubbed with silk will gain a positive charge.

Rubber and glass rods are often used in experiments to establish known charges for use in comparison tests.

The generation of charge by friction is called ***triboelectrity***. Isn’t it wonderful how physics has phancy names for everything?

Charged objects exert forces on one another and obey the fundamental law of static electricity:

***Fundamental Law of Static Electricity ≡ Like charges repel; opposite charges attract.***

Two balloons that have been given a negative charge will repel each other. A negatively charged object will attract a positively charged object.

Here’s another key concept, the principle of conservation of charge.

***Principle of Conservation of Charge ≡ charge is not created or destroyed, merely transferred from one system to another.***

***Back to Insulators and Conductors:***

Conductors are usually metals. The charge is carried through the material by the free electrons that metals have because of their metallic bonds.

Insulators are non-metals; materials like plastic, rubber, ceramics, etc. These substances have their electrons tightly bound in their chemical bonds. The charge can’t go anywhere in these substances because there’s nothing to carry the charge. The electrons are not free to move, don’t you see.

When a charge is placed on an insulator, the charge stays where you put it. When a charge is placed on a conductor it will immediately spread out over the entire object (actually, as we shall see, it travels to the outer surface of the conductor).

***Electrolytes*** are liquid solutions that can conduct electricity. The electrolyte contains ions that transfer charge.