STATIC ELECTRICITY

ANALYSIS

On a dry day, many hapless individuals feel the shock of static electricity after traversing a carpet and touching a door-knob. The circumstances that precede such an event are exactly what Ben Franklin first used to observe and differentiate electric charge.

<u>Charged Particles</u>

All elements are a balance of charged particles: positively charged protons and negatively charged electrons. When the particles are present in equal numbers, the system has no net charge. When there is more of one type of charge (either electrons or protons), then the net charge is either positive or negative.

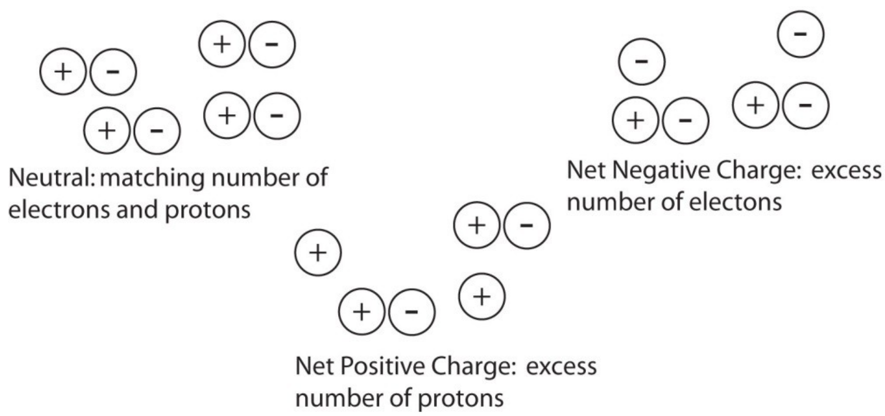

Figure 1: Net charges

When there is a net charge of either positive or negative, the system strongly wants to return to equilibrium. That strong desire can produce a spark. This is the phenomenon that causes lightning bolts. Storm clouds separate charges until finally the electric fields are strong enough to force ions onto the earth in a bolt of lightning.

<u>Friction</u>

From chemistry we learn that elements have electronegativity. This means that some elements are willing to surrender electrons, and others want to capture electrons. This transfer of electrons between these two types of material can be aided by rubbing the materials together. We did this intentionally by rubbing the Teflon and the fur; many people do it unintentionally when they rub their shoes across a carpeted floor or their clothes across a car seat.

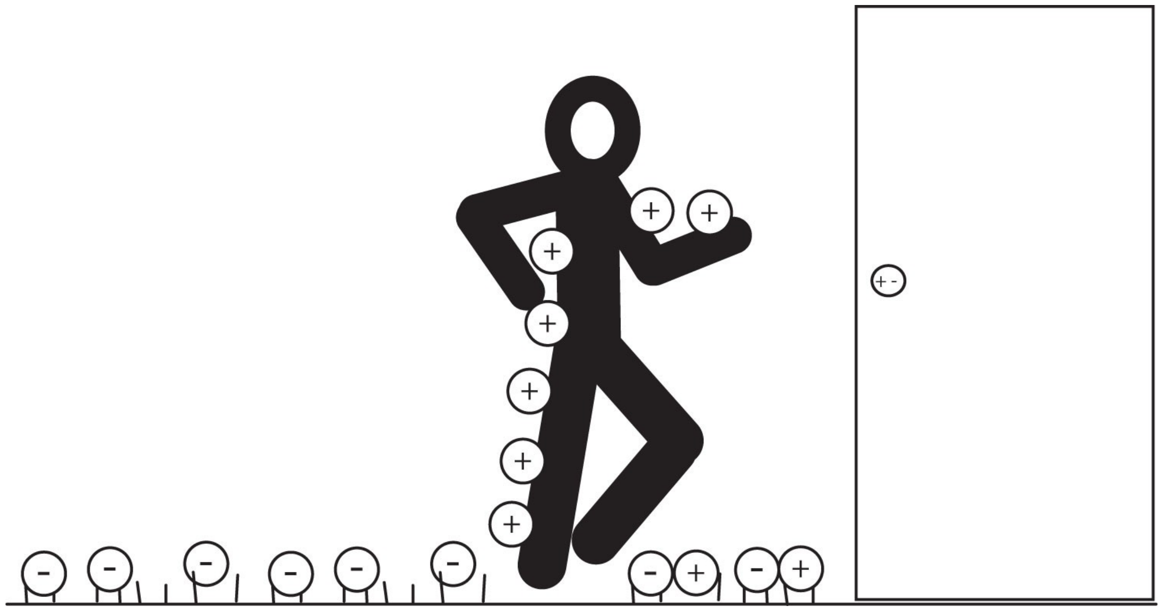

Figure 2: Static charge build-up on person just before touching the conducting door-knob.

<u>Conduction</u>

Charge passes from one material to another when the two materials are in contact. This phenomenon is called conduction. When a person walks across a carpet with their excess charge toward a conducting door, the excess charge passes between the two in the form of a spark.

Materials are classified in two ways: **conductors** pass charge readily, and **insulators** resist passing charge.

Conductors spread excess charge evenly when they come in contact. Silver foil wrappers for Hershey kisses are conductors; this is why when you touch the charged rod to the pith ball charge is transferred. They were in contact, and the charge could readily move on the conductor. When the two pith balls touch, the charged one is able to conduct charge to the other ball.

Insulators resist the transfer of charge, and do not spread it evenly.

<u>Attraction and Repulsion</u>

Once charge has transferred to a pith ball, it has the same charge as the rod. In step 2 you observed that the rod and the ball repelled each other. In step 3 you observed the two pith balls and the rod with shared charge repel each other. Like charges repel.

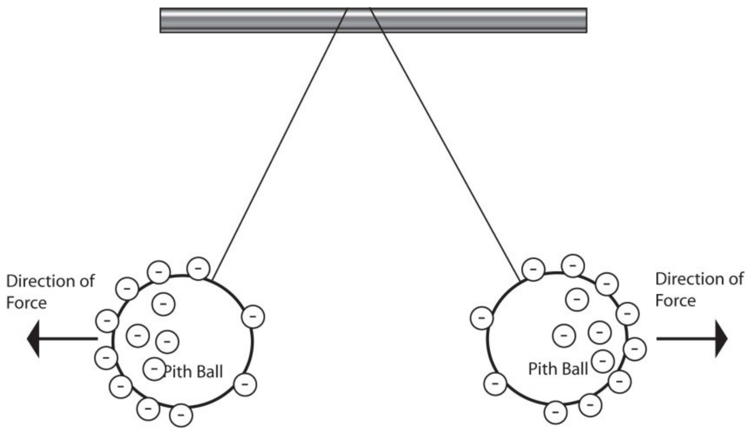

Figure 3: Excess negative charge repelling pith balls

The electronegativity of Teflon can harness excess electrons, creating a net negative charge. Negative charges repel, so the balls and rod repel from one another.

Other materials are unlike Teflon in that they are inclined to forfeit electrons, thus creating a net positive charge. When a positively charged rod comes into contact with a pith ball conductor, the rod takes electrons from the conductor and leaves behind a net positive charge. Positively charged objects attract negatively charged objects to transfer electrons so both can return to equilibrium.

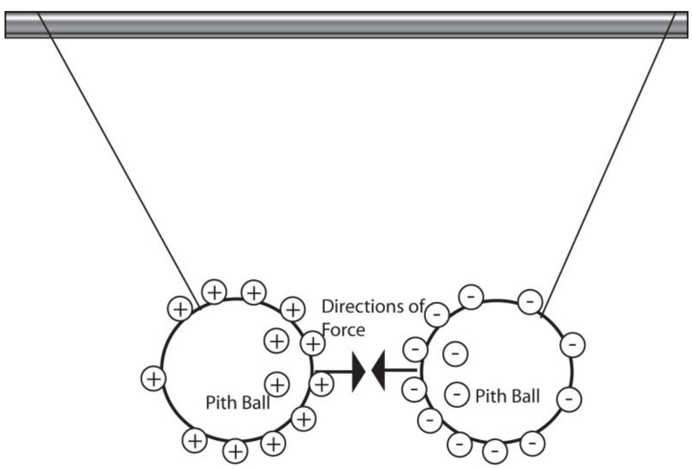

Figure 4: Opposite charges attracting

Polarization

In step 4 you observed a neutral pith ball react to a charged rod. From what we've observed, electric attraction is felt between opposite charges, so why does the ball attract?

Charges are free to move inside conductors. They can shift from one side of the conductor to another in the presence of an excess of charges. This shifting allows a "neutral" conductor to be attracted to a nearby charged object, as shown in Fig. 6.

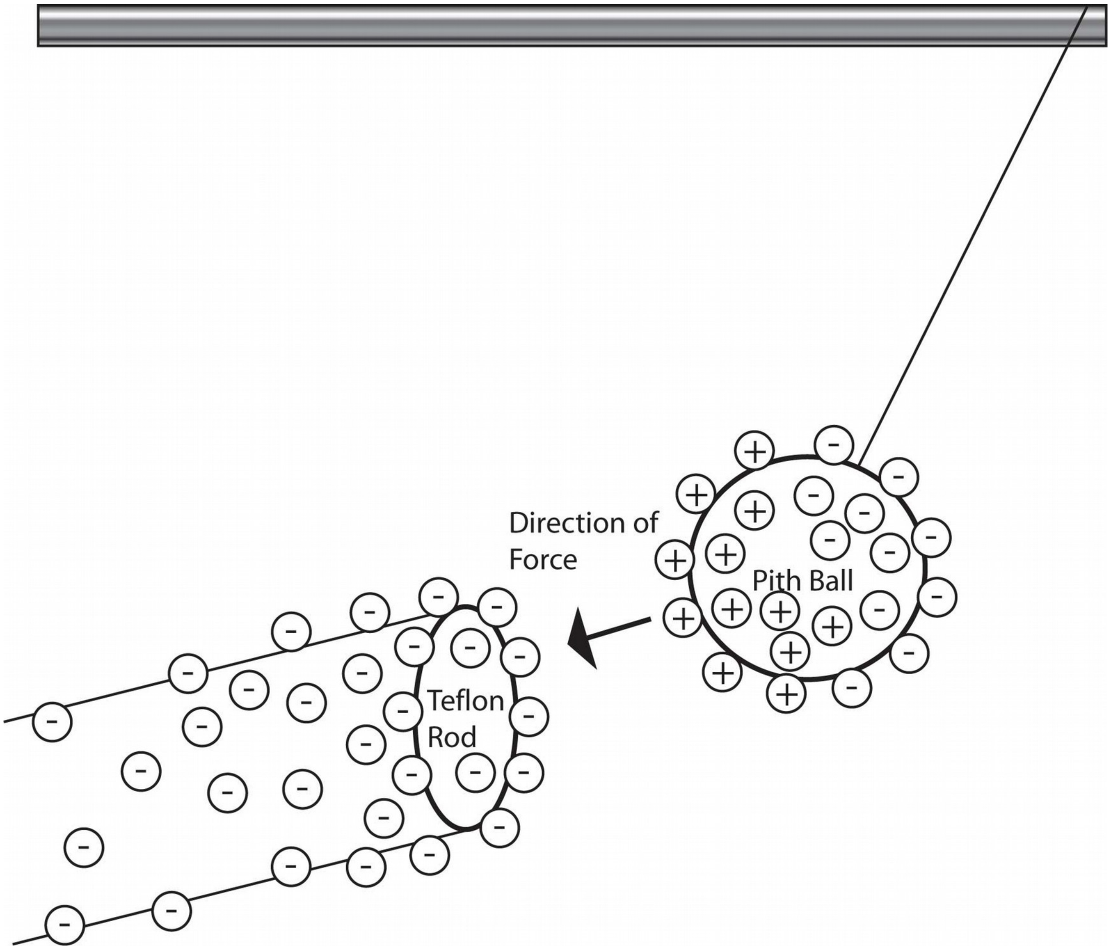

Figure 5: Rod attracting "neutral" conductor that is polarized by the nearby charge