

STATIC ELECTRICITY KIT

STUDY GUIDE

INTRODUCTION

Electricity is of two basic types: current and static. **Current electricity** involves the flow of electrons through a material while **static electricity** occurs when materials are positively or negatively charged.

All material is made of atoms that are in turn made of positively charged **protons** and negatively charged **electrons**. The protons do not move in solids but the electrons are able to move freely in some solids. When electrons build up in a material, it has a net negative charge. When there is a loss of electrons from a material, it has a net positive charge. This is static electricity. This charging of materials is also called **frictional electricity** as it is brought about by the friction of two materials rubbing together.

The **law of charges** states that unlike charges attract and like charges repel. Thus positive repels positive but attracts negative. Negative repels negative but attracts positive. Negatively charged static electricity will try to flow to a positively charged or even neutral material. This flow of static electricity often occurs suddenly in **discharges** called sparks. Lightning is an example of a static electricity discharge between the negatively charged ground and the positively charged clouds.

Materials with static electric charges, if left alone, will lose their charge over time and become neutral.

An **electroscope** is a device used to detect electrical charges. Your apparatus is a simple electroscope in that it will detect whether materials are positively or negatively charged. The pith balls will maintain a static electrical charge. The threads insulate the charge so it does not discharge to the metal hook.

ASSEMBLY

- Open the package which contains:

1 metal hook	1 fur friction pad
1 stand	2 balloons
1 glass rod	2 pith balls connected with a thin string
- Insert the metal hook into the stand. Make sure the hook is standing as straight as possible.
- Drape the string over the metal hook so that the pith balls hang down from the hook together. If the pith balls are not connected, tie them together so that they hang side-by-side about halfway between the hook and the stand base.
- Experiments using your electroscope work best on cool dry days. If your experiments are not

working very well, wait until the weather cools and the humidity decreases. If the weather is too dry, however, the extra static electricity from your clothing might interfere with your results.

- If the pith balls touch the metal rod of the hook, they will discharge whatever charge you have induced on them. Try holding the string below the hook to keep the balls away from the hook.
- Discharge the pith balls after you have given them a charge by touching them with your fingers. This is perfectly safe.
- If the threads become tangled put your finger in the gap at the top of the threads and pull down slightly until the threads unwind. However, don't touch the balls, as this will discharge their static electricity.

ELECTROSTATIC LIST

Whenever you rub two materials together, they become electrified and develop opposite charges. The following list of materials shows how each material will become charged when rubbed with another material. The items higher up on the list will lose electrons and become positively charged while those on the bottom of the list gain electrons and become negatively charged.

For example, if a glass rod is rubbed with rabbit's fur, the glass will acquire a negative charge. However if a rubber balloon rubs the same glass rod, it will acquire a positive charge. The farther apart the materials are on the list, the greater will be the resulting static charge.

Positive (+)

- | | | |
|-----------|--------------------|-----------------------|
| 1. Rabbit | 7. Cotton | 13. Sulfur |
| 2. Glass | 8. Wood | 14. Hard rubber |
| 3. Nylon | 9. Lucite | 15. Vinylite |
| 4. Wool | 10. Amber | 16. Saran Wrap |
| 5. Silk | 11. Polyethylene | Negative (-) |
| 6. Paper | 12. Rubber balloon | |

INDUCTION VS. CONTACT

Experiment 1

Charges can be **induced** at a distance or conveyed by **contact**. When a charged material is brought next to another neutral material, a charge is induced on the neutral material but this charge is not permanent. When contact is actually made between the charged material and the neutral material, the charge is imparted by contact.

- Blow up a balloon and rub it with the rabbit's fur.
- Bring the balloon close to the pith balls without letting the balls touch the balloon. Take the

balloon away and see if the pith balls hang down or repel each other. Repeat, bringing the balloon close to the ball on the other side.

3. Pull up one pith ball with your hand and let the other ball touch the balloon. Don't let the ball touch the metal hook or your hand after it has touched the balloon or it will discharge.
4. Now hold up the charged pith ball by its string (don't touch the ball) and let the other pith ball hang down. Let it touch the charged balloon as well without touch the metal hook or your hand.
5. Let the threads of both balls go and see if the pith balls hang down or repel each other.

The balloon becomes negatively charged when rubbed with the fur (see electrostatic list). It induces a charge on the ball at a distance but this charge is not permanent as the balls return to their normal position. However, when the balloon touches the pith balls, the negative charge is transferred and the balls repel each other, both having a negative charge after touching the balloon.

OPPOSITES ATTRACT AND LIKE CHARGES REPEL

Experiment 2

1. Rub the glass rod with a polystyrene bag (regular ziploc bag) for 30-60 seconds. What charge are you inducing on the rod (look at the electrostatic list)?
2. Hold one ball up by the string and touch the glass rod to the other ball. Repeat this procedure only this time charge the other ball. Don't let either ball touch the hook, each other or your hand when charging them.
3. Let the pith balls hang down. Do they touch? If they do, repeat the above step until they don't touch. What charge do the pith balls have?
4. Pass the glass rod through the center of the balls. Why are they repelled by the glass rod?
5. Rub the balloon with the rabbit fur and bring it up the balls without letting them touch the balloon. Are they attracted to the balloon? What is the charge on the balloon?
6. Allow one ball to touch the balloon until it sparks and jumps back. Allow the pith balls to hang down. Do they touch now?
7. Bring the balloon close to the pith balls and allow both to touch until they spark and are repelled by the balloon. Do the balls touch now when they are allowed to hang down? What charge do the pith balls have now?

The phenomenon of opposite charges attracting is explained by the basic principal that most systems in creation like to be in balance. If one material is

positively charged, it will be attracted to a negatively charged material to balance the charge. Likewise, two negatively charged materials are repelled by one another because they both have an excess of electrons and are both electrically "out of balance."

TEACHING TIPS FOR YOUNG CHILDREN

Introducing scientific terms at a young age helps the comprehension of these terms come more easily in later years. We recommend the following teaching highlights to introduce younger children to static electricity studies with the electroscope apparatus.

Explain that **the friction of two objects rubbing against one another produces static electricity**. One object loses tiny parts called **electrons** and the other object gains these tiny electrons. The object that gains electrons becomes **negatively charged** because the electrons have a negative charge; the object that loses the electrons becomes **positively charged**. Use small circles of paper to be "electrons" and write a "-" on each circle. Hand some to your child and keep some yourself. Shake hands and give some of the electrons to your child. Show the child that when you shook hands, some electrons transferred to her and she now has a negative charge.

A simple demonstration of static electricity is to rub two balloons with rabbit fur. The fur rubs against the balloons and they become charged with static electricity. You will see the fur stand up as it approaches the balloon and may even hear a crackling sound from the static charges.

Discuss the fact that **like forces repel** and **opposite forces attract**. Try to bring the two balloons together. They will repel each other because they both have a negative charge (like forces).

Rub one balloon again with the fur and then listen for crackling noise. Ask your child to bring her finger close to the balloon without touching it. Does she see or hear a spark? Explain that this is the electrons moving from the balloon, where they are built up, to her finger. Discuss how lightning is similar to this spark only much stronger and very dangerous. Ask the child if she can guess why it's unsafe to stand by a tree in a lightning storm.

Let the child observe and participate in the pith ball experiments given in III and IV above. He should be able to grasp the basic principals of charge, attraction, repulsion and discharge.