

TEACHER DEMONSTRATION: DISCHARGING AN ELECTROSCOPE WITH UV LIGHT

Purpose

This demonstration will help students understand that electrons can absorb energy from EMR. Electrons can be ionized from metal, if the EMR is sufficiently energetic.

Materials

Electroscope with flat zinc disk on top (You should scuff up the disk with sandpaper before starting.)

Rubber Rod

Wool Cloth

UV source (preferably a dual lamp with 380 nm and 254 nm UV lamps)

Red and/or Green laser pointer

Before the Demonstration

1. Open the “Balloons and Static Electricity PhET simulation in your browser (see link in narrative). Click “Remove Wall.”
2. Ask students to write down the ratio of positive protons to negative electrons for the balloon and the wool sweater. **1:1**
3. Click the button next to “Show no charges.” Click and drag the balloon across the sweater and ask the students what they think the charge ratio is for the balloon and sweater. **Students may predict that either object is charged with either a positive or a negative charge.**
4. Pull the balloon away and let it go so that the students see the balloon will move to the wool sweater when released. Ask the students why the balloon may be attracted to the shirt. Click on the button next to “Show all charges.” Restate the question from above. **The balloon is negative and the sweater is positive.**
5. Ask the student to compare the amounts of electrons and protons on the balloon and the sweater. **The balloon now has more electrons than protons and the sweater have more protons than electrons.**
6. Restate the question of why is the balloon attracted to the sweater. **Oppositely charged objects attract each other.**
7. Ask the students which charges are being transferred between the balloon and the sweater. **Negative charges or electrons.**

Perform the demonstration

1. Touch the discharged rod to the electroscope to show that the electroscope parts are not moving.
2. Charge the rubber rod by rubbing it against the wool cloth.
 - a. Ask students what is happening during this process. Through discussion, establish that the rod is being charged with negative during this process. You can do this by relating this to rubbing a balloon against the wool sweater.
 - b. Ask students how a net charge could be created on the rod. Establish the idea that the rod is made of atoms which are made up of subatomic particles and that electrons are particles that are more easily removed and transferred between atoms. Students will have to accept that electrons are moving onto the rod from the cloth. Adding negative electrons to the rod creates a net negative charge on the rod.
3. Charge the rubber rod with the wool cloth and touch the rod to the electroscope so that the parts of the electroscope move apart.
 - a. Ask the students what causes the electroscope parts to repel. **The parts repel because both now have a negative charge.**
 - b. Ask the students how the electroscope became charged. **Electrons on the rod repel each other and spread out as much as possible. When the rod touches the electroscope, electrons move from the rod onto the electroscope to spread out. Electrons spread out over the electroscope giving all of its parts a negative charge.**
4. Touch the electroscope with your finger, it will discharge, and the parts will return to their discharged position. Ask the students what may have happened to the electroscope when you touched it. **Electrons on the electroscope repel each other and spread out as much as possible. When the finger touches the electroscope, electrons move from the electroscope onto the finger to spread out.**
5. Recharge the rod. Touch the charged rod to the electroscope to recharge it.
6. Ask the students to predict the result of shining a red laser pointer on the zinc plate of the electroscope. **Students may guess that the leaves will move closer to or farther from each other or that nothing will happen.**
 - a. With the electroscope charged, shine a red laser pointer on the zinc plate. **(Nothing happens.)**
 - b. Repeat with a green laser, if available. Remind students that green photons have shorter wavelengths and are more energetic than red photons. **Nothing will happen.**
7. Ask the students to predict the results of shining UV light with a wavelength of 380 nm on the zinc plate. It may be helpful to review the electromagnetic spectrum and establish that UV light is more energetic than visible red light. **Nothing will happen.**
 - a. Switch the UV lamp to the 254 nm light source. With the electroscope charged, shine 254 nm UV light on the zinc plate. **(The electroscope discharges. This works best with shorter UV radiation)**
 - b. Ask the students what would cause the electroscope to move back to the uncharged position. **Remind them of touching the charged electroscope with their fingers.**

Establish that adding electrons charged the electroscope so removing electrons would discharge it.

- c. Ask students why the red light did not cause the electroscope to discharge, and the UV did cause a discharge. **Electrons require minimum energy to be discharged from atoms. Only the 254 nm UV photons provided the necessary energy to discharge the electrons.**

In the next activity, we will use a simulation to investigate these observations in more detail.

Watch a video [Photoelectric Effect](#) on **slide 40** of the lesson slides to view the demonstration (end at 4:30).