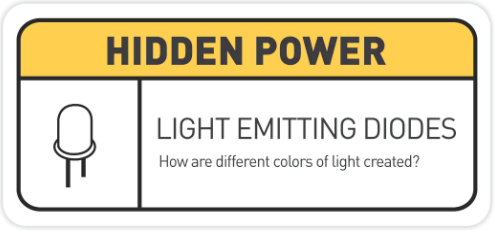

GOAL:

Visitors will understand that LEDs convert electricity to colored light, and that different colors are emitted because diode materials release different amounts of energy.

MATERIALS:

- LED light string
- Extension cord
- Red LED flashlight
- Green LED flashlight
- Blue LED flashlight
- Phosphorescent sheet, with cover
- Catapult model, with cups and landing mat
- 3 plastic launcher balls
- 1 metal ball

PROCEDURE:

Set-up:

1. Plug in the LED light string and drape across the table surface.

2. Set up the model by aligning the catapult with the blank edge of the landing mat and placing the cups in the colored circles. Test the model to make sure the cups are properly positioned to catch the balls.

3. Lay out the rest of the supplies, with the phosphorescent sheet opening toward the visitors.

Doing the demonstration:

1. Ask visitors if they are familiar with LEDs. Introduce the light string as an everyday example of where they might find LEDs, and have them note some of the important characteristics of the lights (e.g. shape, temperature, color). The backlights in electronics displays also often use LEDs.

2. Explain what LED stands for: “light emitting” = gives off light, “diode” = a material inside the bulb where electrons drop from a higher to a lower energy state, giving off light in the process. Each type of material emits a particular color of light.

3. Show visitors the 3 different colored LED flashlights. Ask them to guess which color of light has the most energy and which has the least. Explain that they can check their answers by using the phosphorescent sheet (a special kind of paper that glows green as it absorbs energy; the more energy it absorbs, the brighter it glows). Show visitors how to hold the flashlight directly to the surface of the sheet and move it around as though they were writing on it. They can use the flap to shield

ambient light. Have visitors observe that blue light contains the most energy; red light contains the least.

4. Introduce the model, explaining that it represents three different types of diodes. The metal ball represents an electron losing a high, medium, or low amount of energy during its drop, while the plastic ball represents the packet of light that is produced as a result of the fall.

5. Have visitors predict which diode produces each color of light based on the amount of energy released, and then test their prediction. To operate the model, place a plastic ball on the lever and move the support rod and ramp to the desired level. Allow visitors to place the metal ball on the ramp and let it roll down. When it hits the lever, the plastic ball will be launched and land in the appropriate color-coded cup.

Clean-up:

1. Make sure you have all flashlights, metal ball, and plastic balls. Disassemble the model.

2. Gather all materials and return to storage.

EXPLANATION:

"LED" stands for Light Emitting Diode. LEDs work differently from incandescent light bulbs, using much less energy for a given amount of light produced and producing much less heat in the process. LEDs emit light of specific colors. Inside the LED, free electrons that happen to be excited at a particular level (due to the electricity powering the LED) encounter positively charged atoms that need them. As they are captured, they fall back to a lower energy level and emit light in the process. The light produced is of different colors depending on the amount of energy released as the electron falls (as shown in the model). Electrons that fall farther produce light with more energy, that is, more towards the violet end of the visible spectrum. The amount of energy released depends on the material from which the diode is made.

As a more advanced explanation, diodes are chips made of semiconducting materials where current flows in one direction. In an LED, certain electrons are found to be excited to a high energy level called the "conduction band." When an electron meets a positively charged particle ("hole"), it falls to a lower energy level called the "valence band." The difference between these energy levels is called the "band gap." Different materials used to make the semiconductor have wider or narrower band gaps that release more or less energy, therefore producing different colors of light. For example, blue LEDs must be made of a material with a wider band gap than red LEDs because blue light has more energy.

All LEDs emit light of a specific color. Some examples of materials used to make diodes are: aluminum gallium arsenide (red), gallium (III) nitride (green), and zinc selenide (blue). In order to create white light with an LED, a blue LED is made and then coated in a phosphor that produces white light when excited.

In some ways, the LED light is like the photovoltaic cell in reverse. In the photovoltaic cell, light is used to energize electrons and holes, while in the LED, the process is reversed as energized electrons and holes produce light.

Phosphors, like the material in the phosphorescent sheet, can be made using a variety of different chemicals. What is most important to know about them, however, is that when they absorb light energy, the molecules in a phosphor become excited and glow (with a broader range of wavelengths than an LED, so the light is less colored). Many glow-in-the-dark toys and tools use phosphors.

WHAT COULD GO WRONG?

The balls in the model may become lost or stepped on. Ensure that balls are replaced after each demonstration.

As the model is used over time, the alignment of the catapult may shift slightly. Adjust the position of the cups on the mat as needed to make sure the balls land in the appropriate cup.

GENERAL MAINTENANCE:

The batteries in the flashlights may need occasional replacement.