HIDDEN POWER

SOLAR PANELS

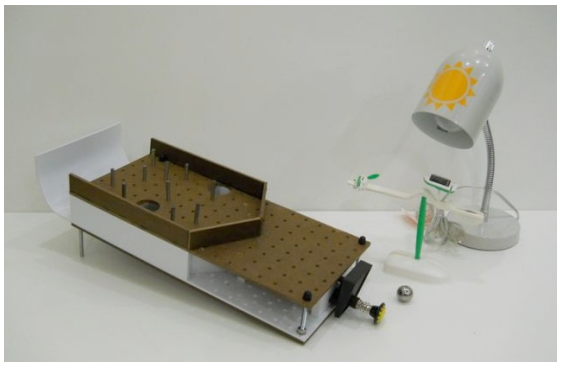
How does the sun's energy make electricity?

GOAL:

Visitors will understand how solar cells function through a molecular model and a small-scale demonstration.

MATERIALS:

- 6-in-1 Solar Kit, set up as rotating plane
- 1 quarter
- Lamp with 100 watt incandescent bulb
- Extension cord
- "Pinball" model
- Metal ball
- 9V battery



PROCEDURE:

Set-up:

1. Pull the "pinball" model out of the box and set up on the table with the facing the visitors. Do not load the metal pinball yet.

2. Set up the solar plane. Balance the arm on the stand by placing a quarter in the slot and adjusting the solar panel so the rotating arm is horizontal.

3. Plug in the lamp but make sure it is off.

Doing the demonstration:

1. Ask visitors if they know about solar cells. Give examples of where they may have encountered one before (e.g. calculator, wristwatch, home garden lights, house rooftops, remote or portable highway signs).

2. Explain that solar cells use a material that absorbs the energy from sunlight and converts it into usable electricity.

3. Show visitors the rotating solar plane. Have them identify the solar panel and point out the wires connecting it to the plane.

4. Turn on the lamp, explaining that it represents the sun. Position the lamp and hold it above the solar cell until the airplane propeller starts spinning. Visitors can move the light closer and farther to the solar cell and observe the effect on the airplane. Turn off the lamp.

5. Show visitors the pinball model with the launcher knob hanging off the front of the cart. Take the metal pinball and explain that the pinball represents an electron, a negatively charged particle in the solar cell. Place the pinball in the launcher by dropping it through the bottom-most hole in the play field through the springs.

6. Ask for a volunteer, and tell them that they represent energy from the sun. Have them shoot the electron; by pulling the pinball launcher, they are acting like the sun adding energy (motion) to the electrons. If the ball makes it to the bottom of the play field, the electron has successfully produced electricity (which is indicated by the LED lighting up). Falling into a hole means that the electron was recaptured by another atom without making electricity. Explain that actual solar cells only convert 20% or less (some only 5%) of the energy in absorbed sunlight into electricity.

7. As an activity extension, have visitors try to rearrange the pegs to help the electron avoid the holes. Explain that the pegs represent defects in the structure of the solar panel and that scientists are currently trying to build panels with a more effective structure so that efficiency can improve to much more than 10 or 20%.

Clean-up:

1. If visitors have arranged the pegs in a regular pattern, return the pegs to a random arrangement.

2. Dismantle the solar plane and put all parts and pieces away.

EXPLANATION:

Solar cells, also known as photovoltaic cells, capture light from the sun and turn it into electricity. Inside a solar cell is a semiconductive material, most commonly silicon with a few phosphorus atoms mixed in. When light hits a solar cell, the energy causes an electron to break free and excites it to a higher energy level, leaving behind a positively charged hole. The solar cell is structured so that electrons are swept to one side of the solar cell and the holes to the other side. Because of this, the only way that the electron and hole can find each other to recombine is for the electron to travel through wires in a circuit and produce electricity along the way.

However, most solar cells are only 10-20% efficient, meaning only that fraction of the light energy absorbed gets converted to electricity. What goes wrong the rest of the time? One reason is that sunlight contains light of many different energies, and most of the light has either too little or too much energy to excite the electron to just the right amount. Also, the electron can recombine with a positively charged hole before it has a chance to escape from the solar cell and produce electricity (represented in the model when the ball falls into a hole before getting to the bottom). This is more likely to happen if the atoms in the silicon crystal aren't arranged in a regular pattern. If one of the silicon atoms is missing, or if the silicon atoms aren't stacked in a regular pattern, then the electron can get stuck at that "defect" before it can get out of the solar cell.

Solar power produces no air or water pollution and requires no fossil fuels, but in 2010 less than 1% of all the electricity used in the United States came from solar cells. Scientists and engineers are currently experimenting with different materials to build solar cells that are less expensive, more efficient, and produce fewer hazardous waste materials during manufacturing.

WHAT COULD GO WRONG?

The solar plane can fall off its stand easily, so have the facilitator handle the plane if visitors would like a closer look.

The solar plane requires an incandescent or halogen bulb in the lamp to produce enough energy for the solar cell. If you use a compact fluorescent or LEDs the plane will not work.

GENERAL MAINTENANCE:

Check to make sure everything is working properly before taking out to the floor. Store the solar cell inside a box or in a dark place. Check the battery on the pinball model if the LED is no longer lighting up.