

PV Cell Model Instructions: Teacher Preparations Before Lesson

This model is meant to demonstrate the different regions of a PV cell and the motion of electrons. One could construct the model with students, but it would likely be more beneficial to build the model ahead of time and have students use it as a manipulative, given the nature of the tools and supplies involved.



The final product is a handheld model of electron movement through the PV Cell. The electrons are either seed beads or tiny glass granules. Instead of becoming excited by incident UV light, students shake the model to input energy and create current. The vinyl tubing represents the portion of the circuit which might include an entire electrical grid, a solar powered battery charger, or any other load powered by the PV cell. Refer to the “educator background information” in the unit plan for detailed information about the structure and electron movement through the circuit.



Consumable Materials with recommended sources:

- **Ziploc Extra Small Square Containers**, two per model. Recommended source: Walmart: \$1.98/8 pack
- **Marbles**: two colors to represent the silicon doped with boron or phosphorus, 13 of one color and 11 of the other per model. Recommended source: Dollar Tree.
- **Clear vinyl tubing**: 1/2” OD, 3/8” ID, approximately 10” per model. Recommended source: Home Depot, approximately \$8 / 20’
- **Seed beads**: Dollar Tree, not available at every location **OR Glass Granules**: Michael’s. You want a small particle that can easily slip through the tightly packed marbles, holes in the model, and flow through the tubing without clumping or sticking. The glass granules were in the miniatures / fairy garden section of Michael’s. Seed beads are more widely available, but more expensive and they flow less easily.
- **Strong clear packing tape**



Tools needed:

- Drill with a bit that is slightly larger than the beads you purchase
- Flat boring bit, 1/2”, to match the outer diameter of the vinyl tubing. One could carefully use scissors for this portion of the project, but the boring bit is faster, neater, and safer.
- Scissors
- Hot glue gun and glue sticks



Step 1: Prepare plastic containers:

- Drill a 1/2" diameter hole in the bottom third of one side of the container.
- Drill a 1/2" diameter hole in the center of the lid. The images above show how to make the holes without the boring bit: drill a pilot hole with a smaller bit, then use the blade of a pair of scissors to gradually widen the hole to 1/2". This method will not make holes that are as neat as with the larger bit.
- Drill several holes (12-15, exact number is not important) in the bottom of a second container. Drill before cutting. This gives a more stable object to drill. With care, it is possible to drill through several containers at once.
- Cut the second container down to just above the marking for 50mL. Drill before cutting. This gives a more stable object to drill.



Step 2: Assemble housing for model:

- Cut vinyl tubing into 10-12" lengths.
- Feed tubing into the holes that you made in the side and lid of the container.
- Use hot glue to fix the tubing in place, as close to flush with the container as you can make it.
- If necessary, use a small drill bit to clear excess dried glue from the inside of the tubing.

NOTE: HOT GLUE JOINS REMAIN SOMEWHAT FRAGILE. Do not stack the models under heavy objects and do not lift them by the tubing. If joins come apart in storage or use, simply scrape off excess glue and reassemble.



Step 3: Add interior elements:

- Determine which color will represent the p-type silicon. Place 11 of these marble in the bottom of the model. If you use marbles other than the ones from the Dollar Tree, you may need more or fewer. You want the marble to be tightly packed, as are atoms in a crystal structure. The marbles should not move. Be sure that no marble is fully over the opening of the tubing.
- Place the drilled part of a container on top of the p-type silicon marbles. (Your depletion layer)
- Add 13 of the other color of marbles. These are your n-type silicon. Again, pack the marbles tightly. You may need to shake the container down to have everything sit nicely.
- Add a scant tablespoon of glass granules or one section of seed beads to your model.
- Close the model and tape shut with packing tape, using one small strip per side.

INSTRUCT STUDENTS TO HANDLE AND SHAKE THE MODELS BY THE CONTAINER! Keep hand on both the top and bottom of the container during use to prevent the lid or tubing from coming loose and marbles or beads from spilling.