PV In Schools

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PV Lesson Plan 1 – Sample Questions and Answers

Prepared for the Oregon Million Solar Roofs Coalition

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Sample questions to check your understanding:

1. What other elements might be used for “doping” besides boron and phosphorous?

2. Why do you need both an n-type and a p-type semiconductor to make a photovoltaic cell?

3. When a photon hits an electron and dislodges it from a bond in a PV cell why doesn't the electron simply fall back into the hole from which it came?

4. Why does the efficiency of a solar cell decrease at higher temperatures?

5. We get energy from photovoltaic cells.
    a. What is the source of that energy?
    b. What are the steps inside the cell by which the electricity is produced?
    c. What must be true about the incoming photon in order for the “light energy” to become “electrical energy”?

(Chemistry students)

6. Draw the electron dot (Lewis) structures for a silicon crystal doped with phosphorus. Draw the electron dot structure for a silicon crystal doped with boron. Show the extra electron or the “hole” on your diagrams.

(Physics students)

7. Why might some kinds of light cause a solar cell to operate while other kinds of light are ineffective?

Suggested answers:

1. Other members of the IIIA family might be substituted instead of boron (like gallium) and phosphorus might be replaced by another member of the VA family (like arsenic). Effective substitution would probably depend on size and electronic properties as well as having 3 or 5 valence electrons. Arsenic is the dopant of choice that is used in single crystal silicon today.

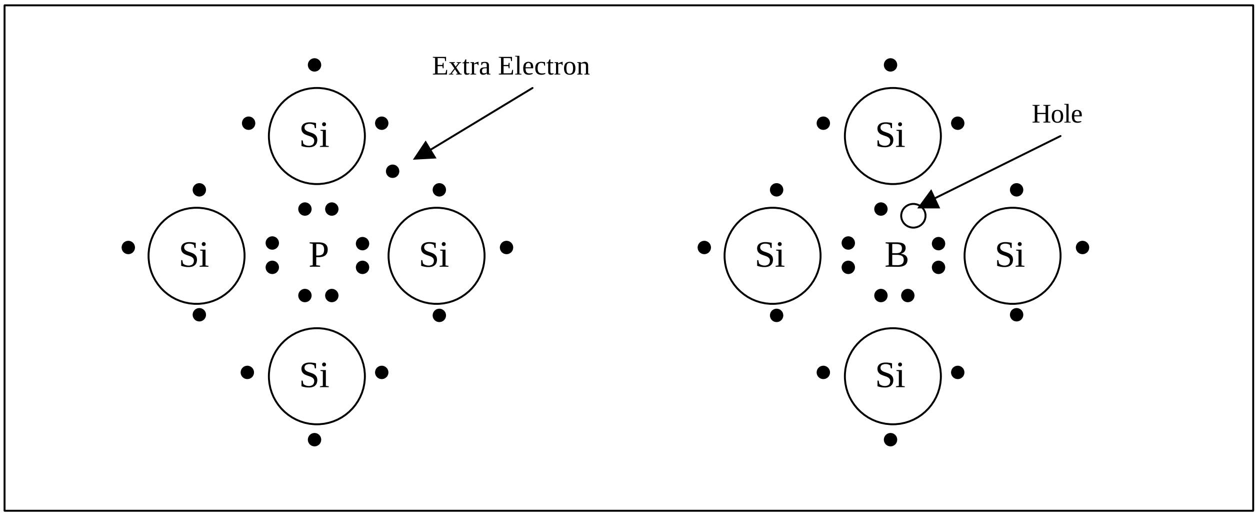
2. You need an n-type and a p-type area close to one another in the crystal because one (n-type) provides the “extra” electrons and the other (p-type) provides the “holes” for them to move into. Only when this has occurred is an electric field established in the crystal--which will cause electrons and holes (produced later by photon interactions) to move. Without the presence of the electric field the electron and hole produced by the absorption of a photon would simply recombine.

3. The electric field at the interface (between the n and p-type semiconductors) causes the electrons to move in one direction while the holes are moved in the other direction.

4. According to the kinetic-molecular theory there is more random, chaotic motion at higher temperatures. The effectiveness of the electric field in moving the electrons in one direction will be diminished

5.
    a. Ultimately the electrical energy comes from the energy in the arriving photons--from the sun or another “light” source. The electrical energy therefore ultimately comes from the sun or another source.
    b. (1) The incoming photon is absorbed by an electron, breaking apart an electron pair in a bond (at or near the p-n junction). (2) Freed from its role in the chemical bond and leaving a “hole” behind, the electron and hole move in opposite directions because of the electric field in the crystal. (3) The motion of charges in the crystal establishes an electric current. Note that the solar cell has to be connected to a circuit for a current to flow.
    c. A photon must have <u>sufficient energy</u> to break the electron loose.

6.



7. To make the solar cell operate, each of the incoming photons must have enough energy to break electrons free of their bonds. Physics students know that E=hf, so the photons' frequencies must be high enough that they are capable of exciting an electron from its bond. Also, the intensity of the light must be adequate--enough photons must be available if you are attempting to run a device like a calculator, for example, or else there may not be enough electric current.