NAME ______________________________

Chemistry of Solar Panels

Adapted from "How Do Solar Cells Work?"by the Environmental Science Institute

Colorado Science Academic Standards:

SC.9-12.1.1.a Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms (HS-PS1-1).

SC.9-12.1.5.c. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials (HS-PS2-6).

Objective: Explain the atomic properties of Silicon, Boron and Phosphorus that make them suitable for use in Photovoltaic Solar cells

Solar cells are materials that transform sunlight energy into electrical energy. In 1954 at Bell Labs, a solar electric effect was demonstrated in silicon (Si) proving that producing usable amounts of electricity from solar cells was possible. Let's take a look at silicon.

1. **Using the provided Periodic Tables, answer the questions below and then draw a Bohr model for Silicon.**
   a. What is the atomic number for Silicon?
   ____
   b. How many electrons does Silicon have?
   ____
   c. How many valence electrons does Silicon have?
   ____

2. **Now, let's simplify our drawings; you only need to draw in the valence electrons. Draw how one silicon atom would interact with 4 other silicon atoms.**

The question is, how do silicon solar cells produce electricity?

Two facts are important to the understanding of how solar cells work.

- First, sunlight is composed of photons of various energies.
- Second, photons can interact with atoms, and if a photon has sufficient energy, it can break the bond between an electron and the atom.

The trick to making solar cells produce electricity is the ability to "collect" the electron once it has been separated from the atom and move from one atom to another. The resulting flow of electrons is called an electrical current.

3. **What happens when light energy hits a silicon atom? Add that on to your diagram above.**

To create an electric field, solar cells are not made of pure silicon, instead they are constructed like a battery. This is done by taking two other semiconductors (Boron and Phosphorus) of opposite charge and putting them next to each other.

4. **Using the provided Periodic Tables, answer the questions below and then draw a Bohr model for Boron and Phosphorus below.**

a. What is the atomic number for Boron?

____

b. How many electrons does Boron have?

____

c. How many valence electrons does Boron have?

____

d. What is the atomic number for Phosphorus?

____

e. How many electrons does Phosphorus have?

____

f. How many valence electrons does Phosphorus have?

____

Boron Bohr Model

Phosphorus Bohr Model

5. **How will the number of valence electrons influence how the different atoms (B and P) behave when light energy (photons) hit it?**

6. **Together, let's draw how a solar cell works when light hits it.**

Questions for Reflection:

1. What atomic properties make Silicon a useful material in solar cells? Looking at the periodic table, are there other elements that might be used for the same reasons?

2. What atomic properties of Boron and Phosphorus are useful when they are added in small amounts to Silicon solar cells?

3. Describe the movement of electrons when the different doped layers (B and P) of Silicon are joined together. Do electrons travel across the p-n junction to balance charges? Why or why not?

4. Describe how a solar cell is similar to a battery.

5. What happens when energetic light photons interact with the Silicon solar cell with an external load (wire)?