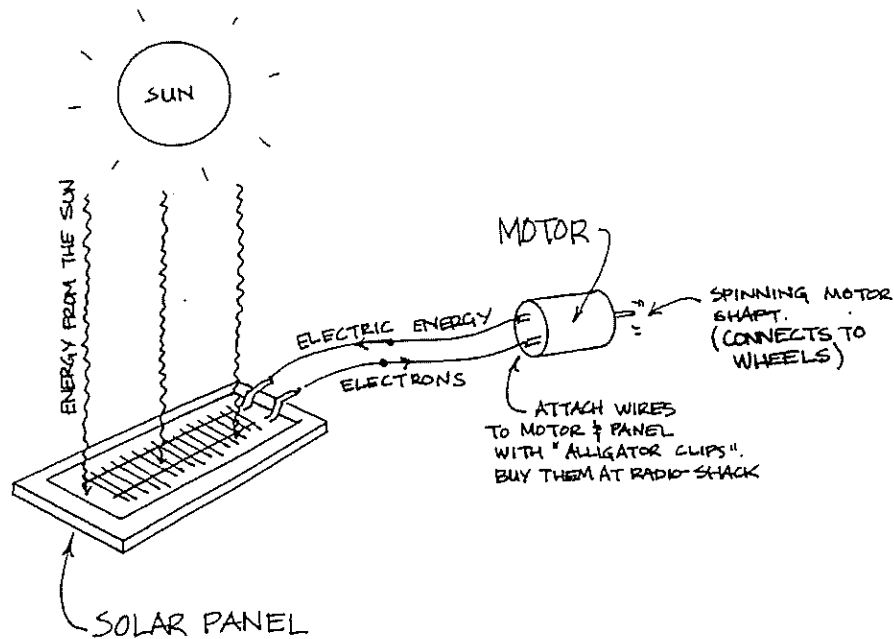


## Power Source: The Solar Panel and Electric Motor

### Purpose

The purpose of the solar panel is to capture energy from the sun and to turn this energy into electrical energy. The electric motor then uses this electrical energy to power the wheels of the solar car.

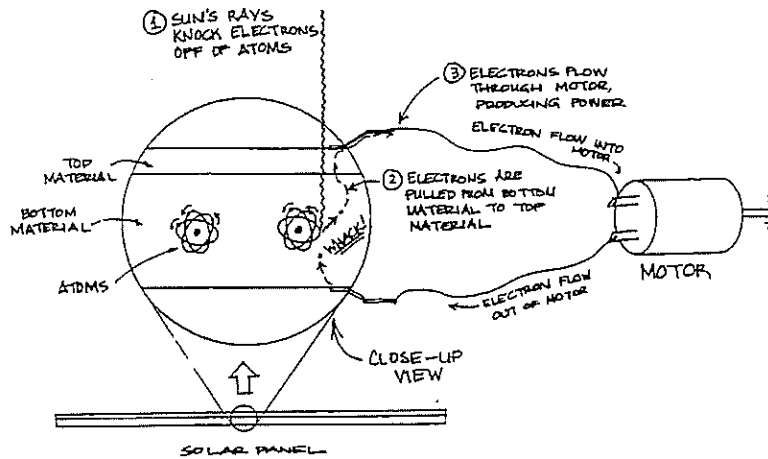


### Concept: Solar Power

#### How the Solar Panel Works

When you look at the picture above, you might ask, "How does the solar panel turn the sun's energy into electric energy?"

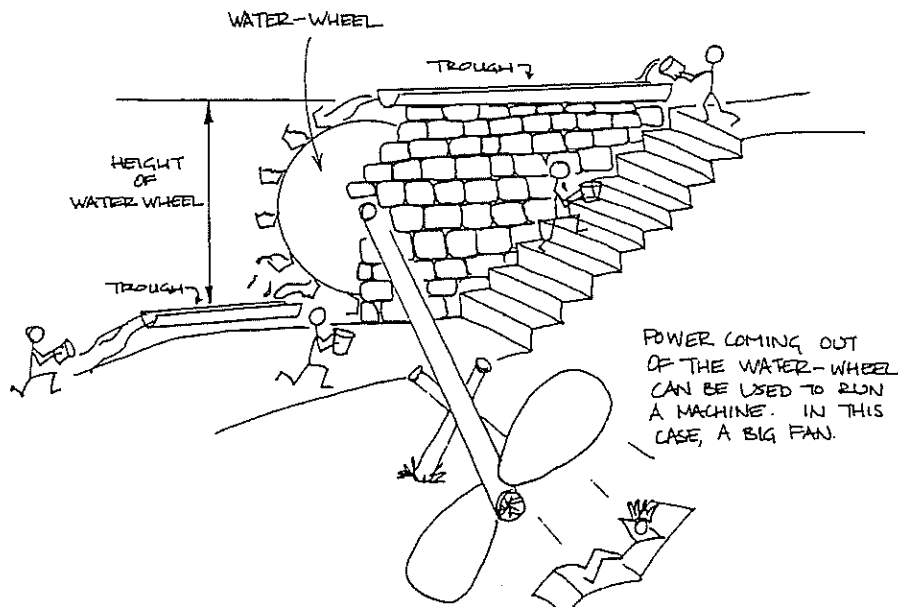
The solar panel is made of a sandwich of two materials called *semiconductors*. Each material is made of millions of atoms. As you might already know, atoms have a positively charged *nucleus*, and negatively charged *electrons* which spin around the nucleus. When these two materials are put together in a sandwich, an interesting thing happens: electrons become pulled from the bottom half of the sandwich to the top half. But there's a problem. The electrons are all attached to the atoms, and the atoms won't let go very easily. This is where the sun's energy helps out. If we shine sunlight on these materials, the sunlight has enough energy to knock the electrons off the atoms. The electrons will then be free to be pulled to the top of the sandwich.



Now if we connect wires to a motor, electrons will flow through the wire into the motor (making it spin) and back through another wire to the solar panel where they can fill the “holes” left in the atoms who lost their electrons.

## Power

How does such a solar panel create power? To understand power more clearly, let’s look at a mechanical example to illustrate the main ideas. For example, imagine a water wheel, like the one below:



This doesn’t look very much like a solar panel and motor, but we’ll see that in many ways they’re actually quite alike.

In this example, people have to climb stairs to carry buckets of water up a hill, and then pour the water into a trough. The water flows down over a “water-wheel”, which has buckets attached to it that catch the water. The weight of the water in the buckets is what makes the wheel spins. Now, we can use the power of the spinning wheel to run a machine, like the big fan in the picture.

For the water-wheel, the *power* coming out depends on two things:

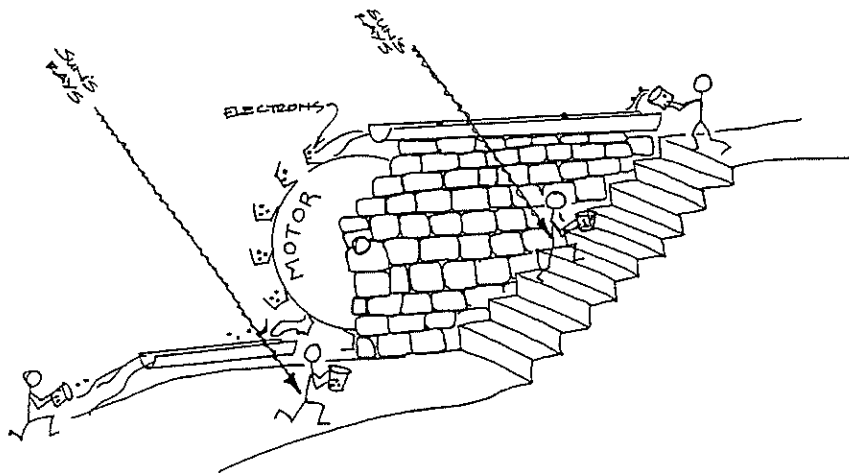
1. How *high* the water falls, and
2. How *much* water (how many buckets) is poured over the wheel.

In fact, the power you get is:

$$\text{Power} = \text{Height} * \text{Amount of water}$$

The larger the height of the wheel, the more power we get, and the more buckets of water we pour over the wheel, the more power we get.

Now let’s think about the solar panel and the motor. Imagine that the electrons are buckets of water, the wires are like the troughs, and the electric motor is the water wheel. In the solar panel, then, the sun’s energy is used to carry the electrons up an electric “hill” inside the solar panel, then they are “poured” down through the motor. So, if we drew the picture again for the solar panel, it would look like below:



In the solar panel, a very similar equation for power is true as for the water wheel. But instead of height, we have what is called *voltage*, and instead of buckets of water, we have *electric current* (or number of electrons flowing through the motor).

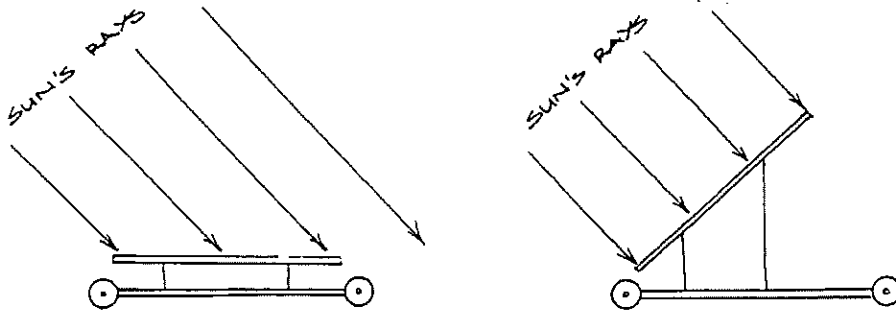
The *power* coming out of the solar panel is the product of the voltage and the number of electrons flowing (the current):

$$\text{Power} = \text{Voltage} * \text{Current}$$

## Maximizing Power

How can we build the solar car so it gives us the most power from the solar panel? One way is to try to get the solar panel to produce more current. To produce more current, more electrons need to be forced to move inside the panel. If more sunlight hits the solar panel, more electrons are knocked away from the atoms in the solar panel and more current is then produced!

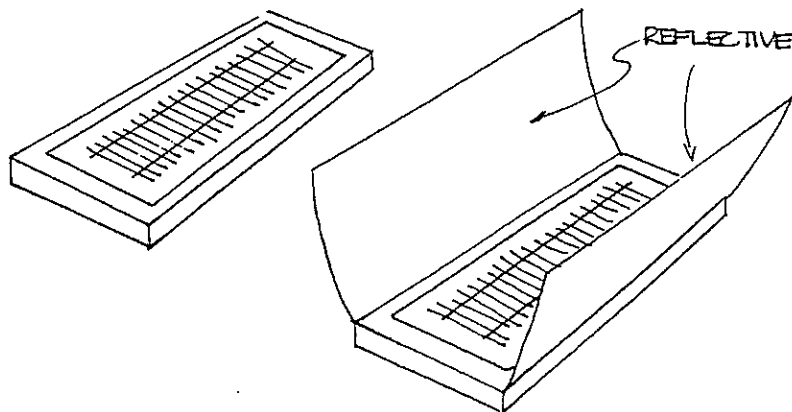
How can we do this? One way is to tilt the solar panel towards the sun. The more of the sun's rays hit the panel, the more current will flow and the more power will be produced. Think of the following two cars:

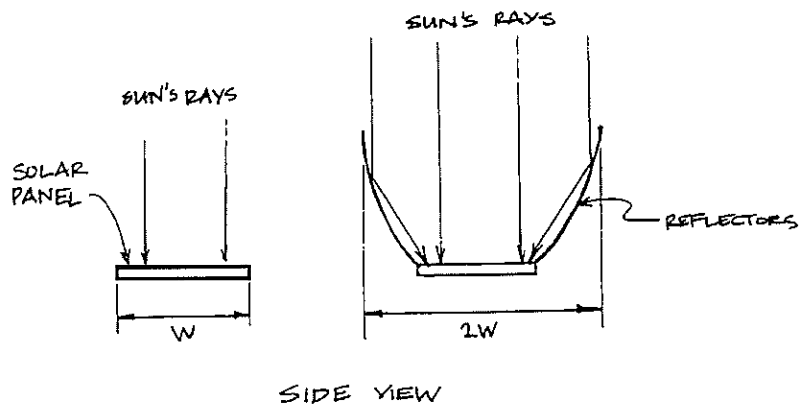


Which one would have more power? In this case, car B would, because it has more sunlight hitting it than A does:

Of course, the best way to tell if this will affect your car is to try it with the solar panel mounted at different angles – experiments are the best way to find out.

Another idea that you might want to experiment with is using a reflector to capture more sunlight with the solar panel.





On the right, a reflector that is twice as wide as the solar panel could be made to direct twice as much sunlight to it. This would double the current coming out of the solar panel and double its power!

The disadvantage is that the car would be heavier with a reflector, and a heavier car will be harder to move. Also the reflectors might add air drag or get caught in side winds causing the car to top over. But, as usual, the only real way to find out is to build one and see!