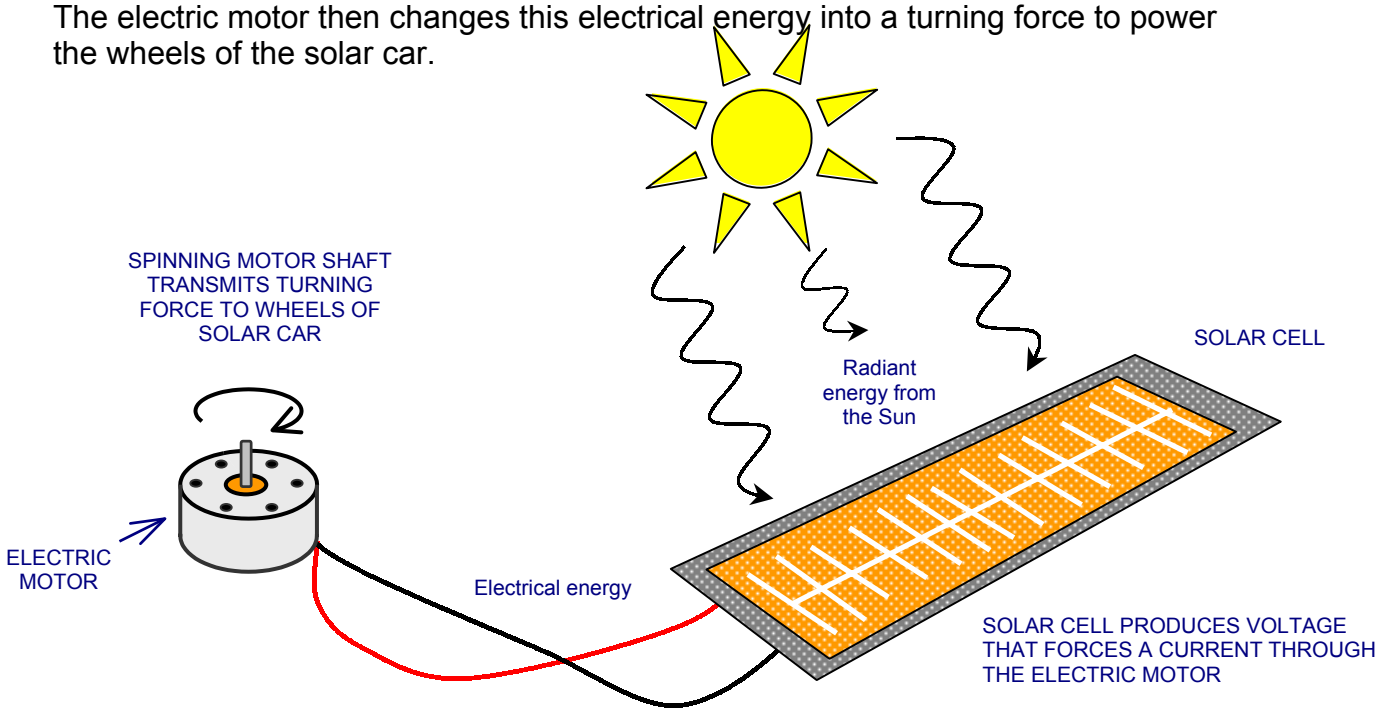
Solar Powered Cars

How does the Sun make the solar car wheels spin?

The purpose of the solar cell is to capture energy from the sun and to turn this energy into electrical energy.

The electric motor then changes this electrical energy into a turning force to power the wheels of the solar car.



How the solar cell works.

The solar cell is made of a sandwich of two materials called *semiconductors.*

Each material is made of millions of atoms.

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 electric field is created inside and 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 atoms, and the atoms won't let go very easily.

Words and pictures derived from material originally published by Minnesota Renewable Energy Society.

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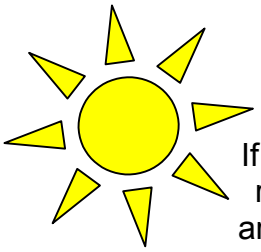
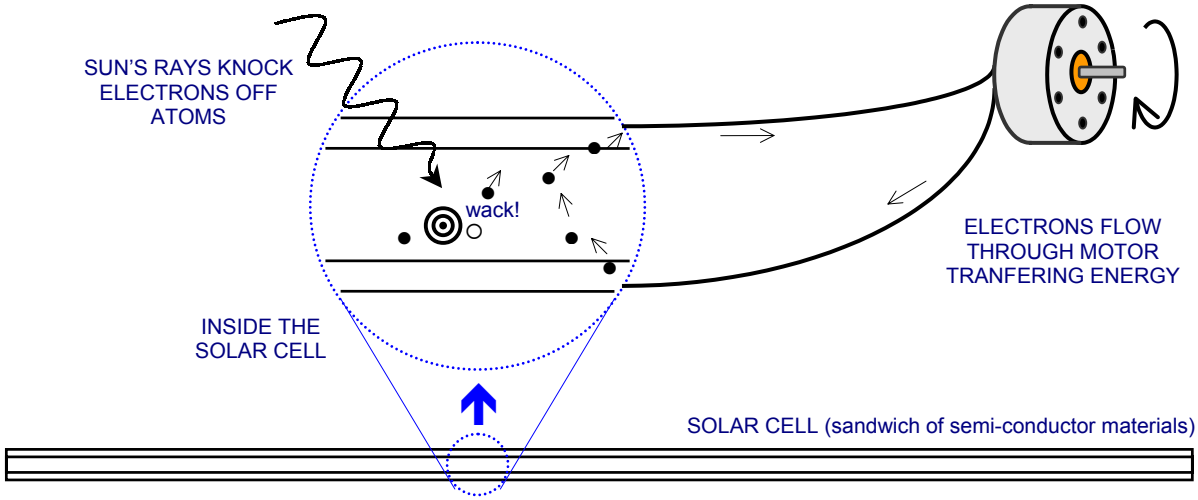


This is where the sun's energy helps out.

If we shine sunlight on these materials, the electrons can absorb enough radiant energy to escape from the atoms. When this happens 'holes' are left where the electrons once were.

The electrons will then be free to be pulled to the top of the sandwich.

This is how the Sun's energy separates electric charges (electrons & holes) in the solar cell and moves them to the negative & positive terminals, creating a voltage.

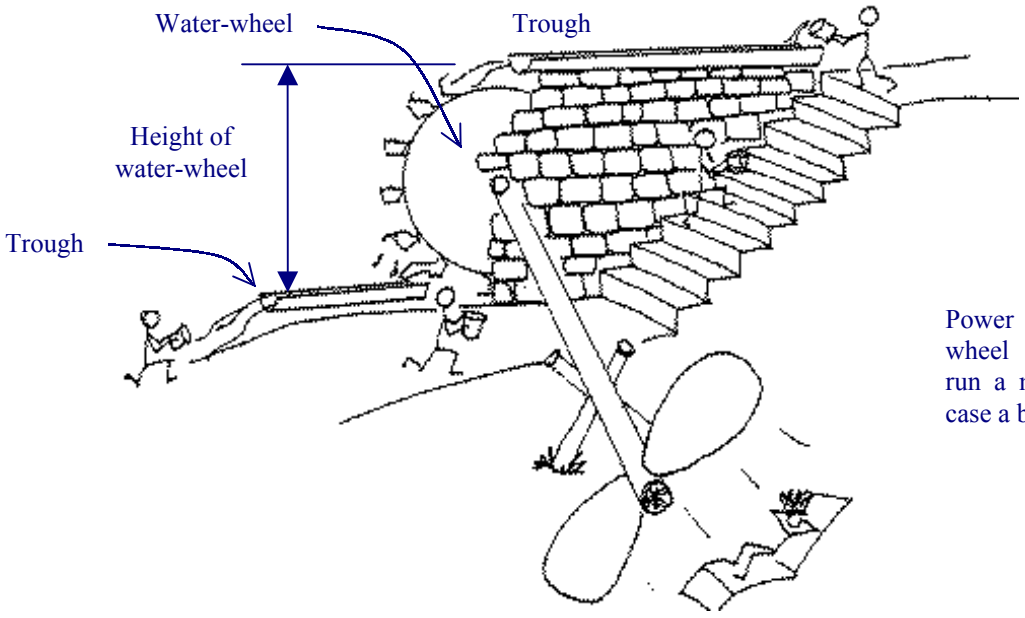


Now if we make an electric circuit with wires connecting the cell and a motor, electrons will flow through the motor (making it spin) and back to the solar cell where they can fill the "holes" left in the atoms which lost their electrons.

Power.

How does a solar cell create power?

To understand power more clearly, let's look at a water wheel as a mechanical example to illustrate the main concepts.



Power from the water-wheel can be used to run a machine (in this case a big fan)

This doesn't look very much like a solar cell 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 (working against the force of gravity), 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 spin.

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 far the water falls

2) How much water (how many buckets) is poured over the wheel.

We can write this in an equation: Power = Height x Amount of water

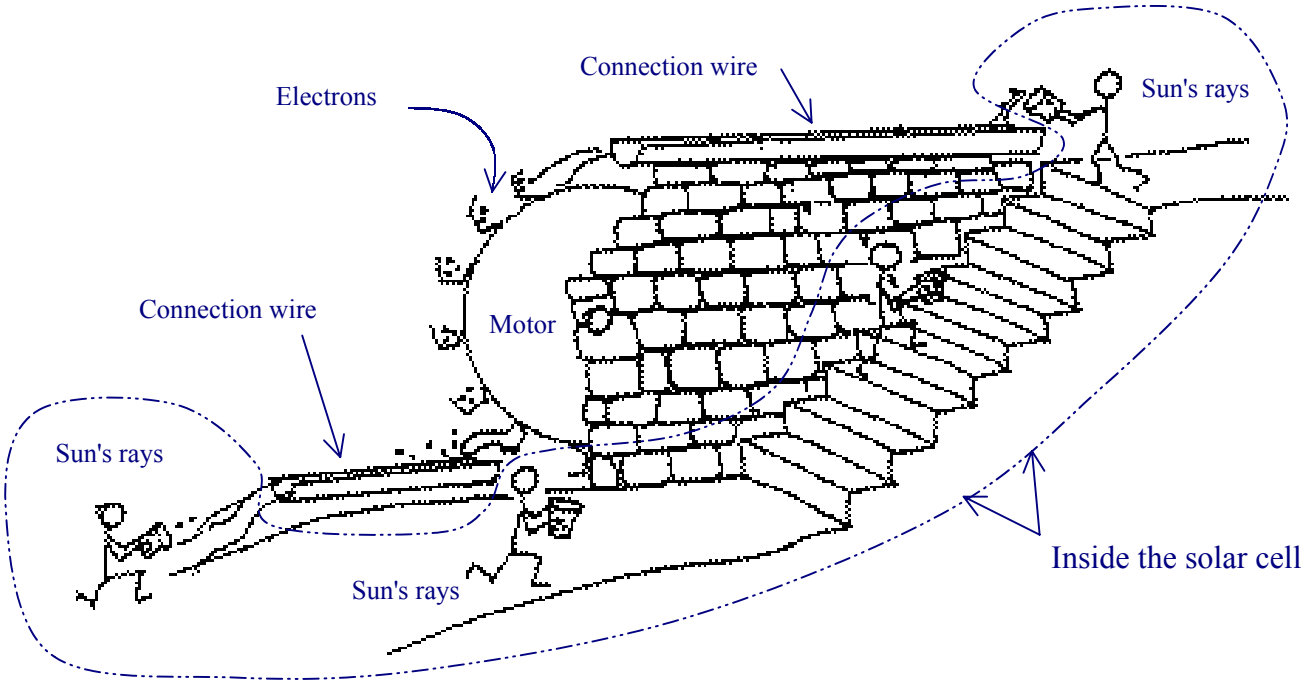
showing that if the height of the wheel or amount of water is increased, then more power is produced.

How does this help us understand the solar cell and electric motor?

Imagine that the electrons are buckets of water, the wires are like the troughs, the electric motor is the water wheel, and the Sun's rays do the job of the people.

The solar cell absorbs the sun's energy, using it to carry the electrons up an electric "hill" inside the solar cell, then they are poured down through the motor.

So, we can draw another picture to represent the solar cell and electric motor:



A similar equation for power is true in the solar cell as for the water wheel.

But instead of height, we have voltage (measured in volts), and instead of buckets of water, we have electric current (or flowing electrons) (measured in amps).

The power (measured in Watts) produced by the solar cell is the product of voltage and current.

Power = Voltage x Current

Maximising Power

How can we build the solar car so that it gives us the most power from the solar cell?

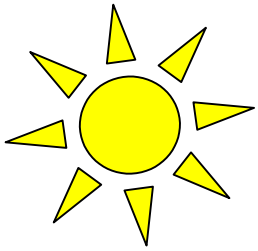
One way is to try to get the solar cell to produce more current.

To produce more current, more electron movement needs to be forced within the cell.

If more sunlight hits the solar cell, more electrons are knocked away from atoms in the solar cell and more current is then produced.

How can we do this?

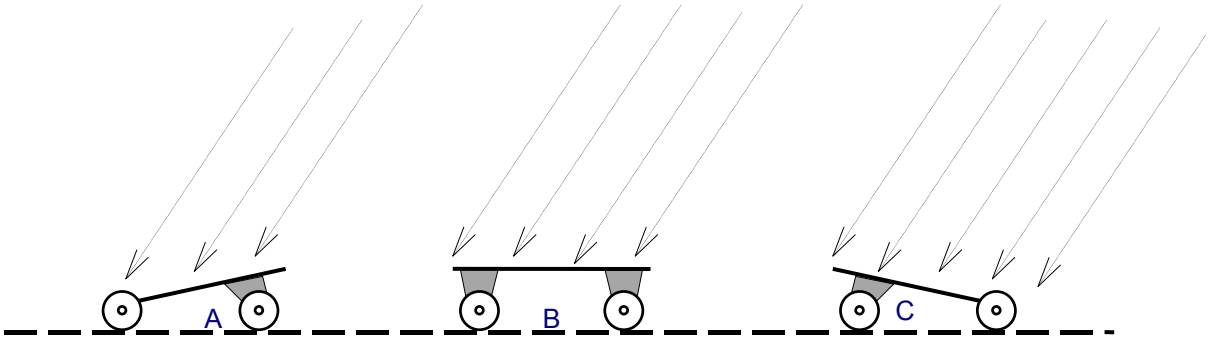
One way is to tilt the solar cell towards the sun.



As more of the sun's radiant energy hits the cell, more current will flow and more power will be produced.

Consider the following three cars:

Notice how the solar cells on top of the cars are facing in different directions.



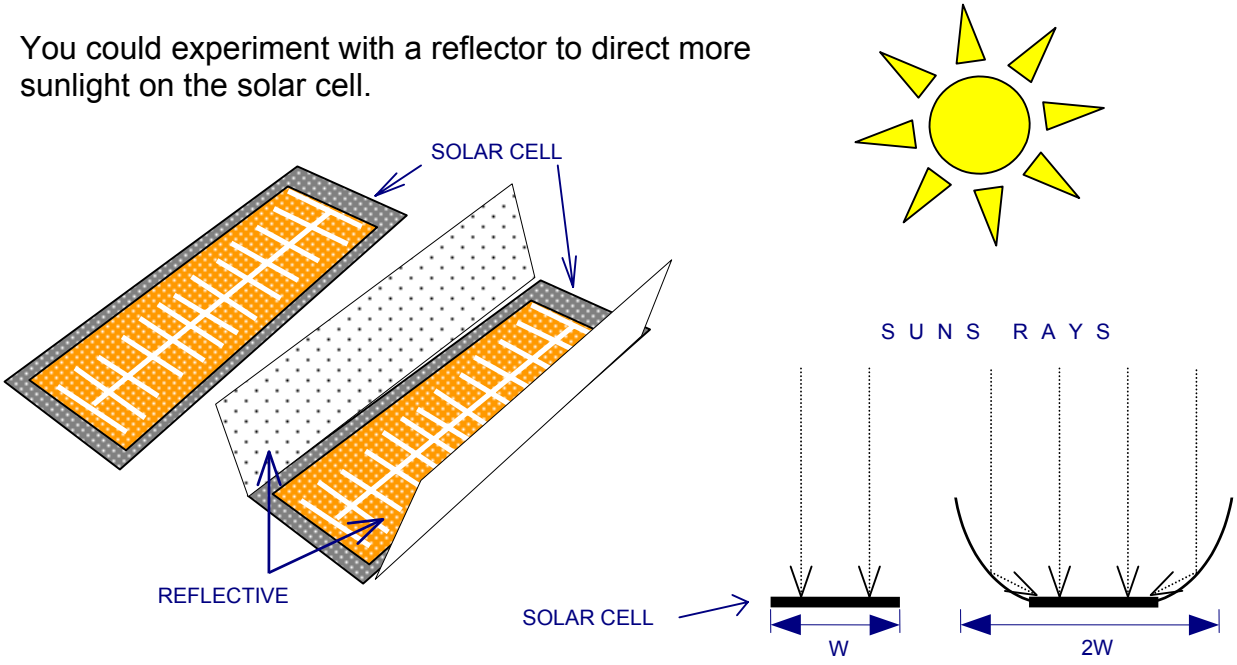
Which one would have more power?

In this case car C would because it intercepts more sunlight than A or B.

The direction that the solar cell faces makes a difference to the amount of light hitting it.

Find out how the direction that the solar cell faces affects the performance of your solar car.

You could experiment with a reflector to direct more sunlight on the solar cell.



A reflector twice as wide as the solar cell can be made to capture twice as much sunlight.

Double the current coming out of the solar cell means double the power.

One disadvantage is that the car with a reflector would be heavier and it would take more power to move.

Reflectors might add air drag or get caught in side winds causing instability.

The best way to find out is to build one and experiment.

Notes: