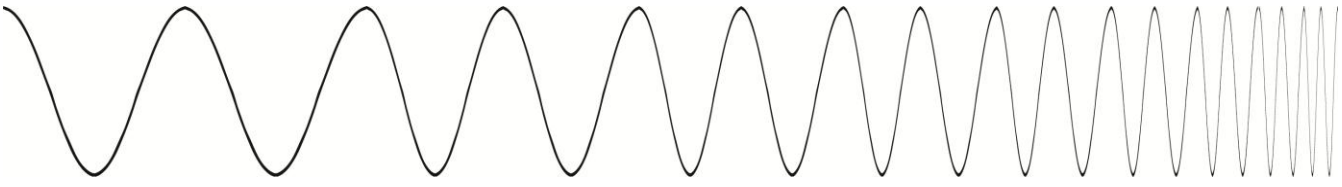
SOLAR JITTERBUG
The expanded science behind the activity

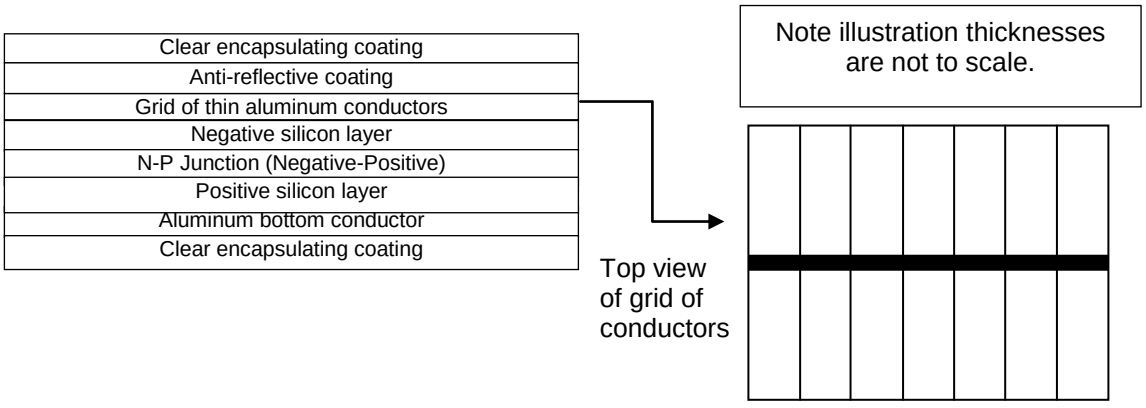
Science behind the solar cell

Sunlight that reaches the Earth's surface is made up, roughly, of 2 equal parts, light we can see (visible light) and light we cannot see. The part we cannot see is made up of infrared light (heat) and a smaller amount of ultraviolet light (UV = sunburn). The light we see is composed of the rainbow of colors from red to violet. Infrared light has longer wavelengths than red light while ultraviolet light has shorter wavelengths than violet light. Light with shorter wavelengths will have higher energy than light with longer wavelengths.



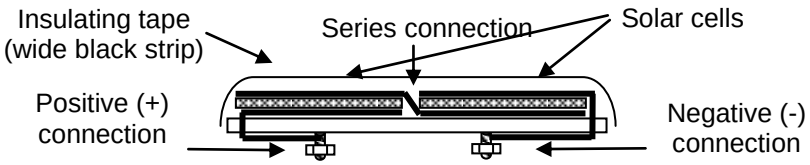
Infrared – red – orange – yellow – green –blue – indigo – violet – ultraviolet

A solar cell is a created with special layers of materials that perform different functions. Currently the most common type of solar cell is created from silicon, a semiconductor element that does not conduct like a metal nor insulate like plastic. The top layer of the solar cell is a clear coating added to encapsulate and protect the cell. The next layer is an anti-reflective coating so more light can enter the cell. The anti-reflective coating gives the solar cell the commonly seen dark-bluish coloration. Under the coating is a grid of thin aluminum lines. The lines are conductors that collect freed electrons. The conducting grid is on top of a section of silicon that has been specially treated (doped) to have 3 separate regions. The top negative layer, which has electrons that could be freed to move about, is above a positive layer, which has places that can accept electrons. At the junction between the two regions is an area called the N-P junction (negative-positive). This junction creates electrical fields that encourage any freed electrons to move in one direction, toward the negative layer. On the bottom of the silicon is an aluminum layer that acts as a conductor for electrons to return to the solar cell.



When visible and infrared light of the correct energy levels reaches an interior layer (the n-p junction) the light is absorbed and knocks an electron free. The freed electrons were not created - as all the electrons were always present in the layers of the solar cell. The electron, which had been bound to an atom, can now move about among the other atoms in the solar cell, 'bumping' other electrons out of place. A grid of thin aluminum lines (wires) on the surface of the solar cell provide a path for the electrons to push along so some electrons can leave the solar cell. The thin lines cross a slightly wider aluminum conductor call a "bus" and the bus can be connected to another solar cell or to an outside connection. The bottom of the solar cell has a layer of aluminum to act as the conductor for electrons to return (be pushed/pulled back) to the solar cell. The bottom conductive layer is covered with an encapsulating layer and can be wired to a second, positive, outside connection or to another solar cell.

The connection to another solar cell within the same unit might be covered such that the connection cannot be seen. The reason solar cells are connected together is to provide a greater "push" (higher voltage), just as when a flashlight uses 2 batteries connected in series instead of a single battery. Each solar cell can produce about ½ a volt so 2 cells connected in series can produce about 1 volt. When 2 or more solar cells are connected together within the same unit the combination should be called a "solar panel". However when the combined unit is rather small, the term "solar cell" is often used.



Electrical Energy into Motion

The movement of electrons in a wire will create a magnet field around the wire. By coiling the wire round and round the magnetic fields of the individual wires are combined to make an even stronger magnetic field. The small motor contains a curved permanent magnet that surrounds a coil of wire on a moveable center rotor. There are metal contacts connected to the metal tabs at the back of the motor that touch a part of the rotor that has alternating metal (conducting) and plastic (insulating) sections. The conducting sections are connected to the ends of the coils of wire. When the tabs at the back of the motor are connected to a battery or solar cell the movement of electrons in the wires creates a magnetic field that is repelled by the magnetic field of the permanent magnet. Since the rotor is free to turn the rotor turns, pushed away by the like magnetic poles and attracted by the opposite magnetic poles of the 2 magnetic fields. The turning rotor moves the conducting and insulating section of the rotor such that the metal contacts now touch connections to a different set of coils oriented so the magnetic field will again be repelled away and attracted towards the permanent magnet's poles. The process repeats so that the rotor spins in one direction. If the connections to the battery or solar cell are reversed then magnetic fields of the opposite orientation will be created. In that case the rotor will spin in the opposite direction.

Resources

Solar cell - http://www.imagesco.com/articles/photovoltaic/photovoltaic.html and http://library.thinkquest.org/04apr/00215/energy/solar/solar_cells.htm