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Solar Cells and Circuits Instructions:

Exploring series and parallel circuits in relation to solar energy.

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Solar Cells and Circuits

Introduction

Solar cells need to be connected in an **electrical circuit** to be able to produce electricity. With any electrical circuit, it needs to be **complete** to allow electricity to flow through it and power electrical devices. All the wires must go in a **full loop** from the power source and back again, and if there are any gaps in the circuit, electricity will not flow.

There are 2 different ways in which circuits can be connected: **series** and **parallel**. This activity will demonstrate how solar cells can be used in an electrical circuit, and how connecting them in different ways will produce different results.

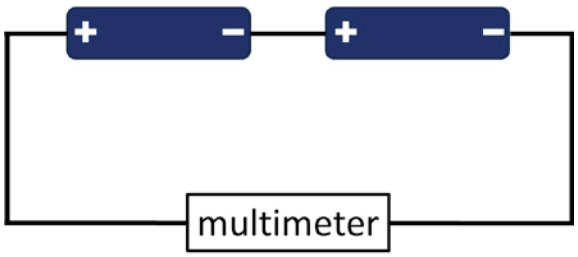
Equipment

- Solar cells
- Wires and crocodile clips
- Small electrical components (e.g. small bulbs, fans, buzzers)
- Light or torch (or sun!)
- Multimeter/Ammeter

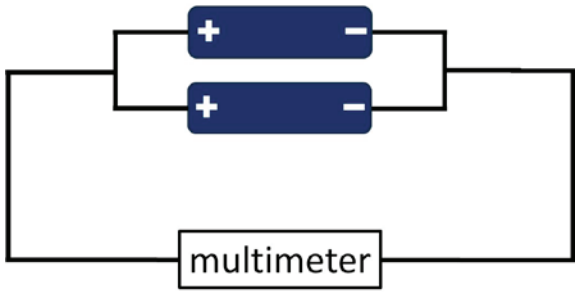
Method

Attach a solar cell to the multimeter using crocodile clips and measure the voltage and current. Shine light (from a torch or sunlight) onto the solar panel and watch what happens to the voltage and current.

Now, using the diagrams below to help you, connect two solar cells together first in **series** and then in **parallel**. What happens to the values of the voltage and current?



Solar cells connected in **series**



Solar cells connected in **parallel**

Series circuits have no 'branches' in them; you can follow the path of the electrical current from one end of the cell to the other through all of the components without any branches.

Parallel circuits contain components which are connected on different branches of the wire. To pass through all of the components, you must follow all of the branches.

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The Solar Spark

Now try building circuits to power small electrical devices such as bulbs, fans and buzzers. Start by connecting only one device, then connect a few. Try both series and parallel circuits.

- *Do the devices work with just one solar panel?*
- *If you need to connect more than one solar panel, should you connect them in **series** or in **parallel**?*
- *If you have a **series** circuit and one of the electrical devices is disconnected, what happens to the other devices? Do the still work?*
- *If you have a **parallel** circuit and one of the electrical devices is disconnected, what happens to the other devices? Do they still work?*
- *Try using LED torches to illuminate the panels. Can you get any devices to work?*

What is going on?

When circuits are wired in **series**, the voltage (V) of each panel is added together, but the current (I) remains the same. In a series circuit, every device must function for the circuit to be complete, so if one device stops working or is disconnected, the all other devices in the series circuit will stop working.

When circuits are wired in **parallel**, the voltage of each panel remains the same and the current of each panel is added. In a parallel circuit, each device has its own circuit, so if one or more device stops working or is disconnected, electricity can still flow to the other devices (provided they are not connected in series with the broken/disconnected devices).

LED lights are not suitable for using with solar panels. We are using torches to imitate the Sun, and 'incandescent lights' (such as non-energy saving bulbs and torches), do this very well. However unlike incandescent lights, LED lights utilise a very narrow part of the solar spectrum and as a result the optical power output is actually very low. Even 'white' LED lights are tuned to be pleasing to the human eye. Most LEDs do not produce enough irradiation to power the panels.

Using solar panels and circuits in our houses

We can use these two different ways of connecting circuits to wire solar panels together to power the electrical appliances in our houses using energy from the sun.

Solar cells are the building blocks of **solar panels**. In one solar panel there are many individual solar cells. Solar cells are sometimes called **'photovoltaic'** or **'PV'** cells (from the Greek word 'photo' meaning 'light', and 'voltaic' meaning voltage or electrical current).

The PV cells in a panel can be wired to any desired voltage and current by connecting them in series to increase voltage and in parallel to increase current. The panels can then be wired together to create **'PV arrays,'** providing us with enough energy to power our electrical appliances.